CREATING A MODBUS CONFIGURATION USING THE DF89

Introduction

This section will present how to configure a strategy using the DF89 as controller. The DF89 controller can operate in several Modbus scenarios. Therefore different application approaches will be shown throughout the topics of this section.

NOTE
• The characteristics of the DF89 described in this section are only available from the firmware version 4 (V4.xx) with Device Description 4.xx. • The Modbus configuration characteristics of firmware versions prior to 4 are the same as described in section “Adding Modbus” of this manual. • The DF89 only has RS-485 port from the serial number SN623. • Modules with serial number less than SN623 support firmware version 4 and features described in this section only for RS-232 serial port.

To illustrate the configuration, consider as example a process has two transmitters, one slave, one IHM and one supervision station (HMI). The network architecture is shown on the figure below. The scenarios used as examples are:

1) The DF89 stands for the RTU Modbus master of the slave PLC (PLC_ID1) and the slave transmitter (TRM_ID2) on the RS-485 serial port.
2) The DF89 stands for the TCP Modbus master of the slave transmitter (TRM_ID3) on the Ethernet.
3) The DF89 is the TCP Modbus slave for the IHM (IHM Master).
4) The supervision station (HMI Master) can read the DF89 data (concentrator) or the data directly from the slaves on the DF89 serial port (Bypass).

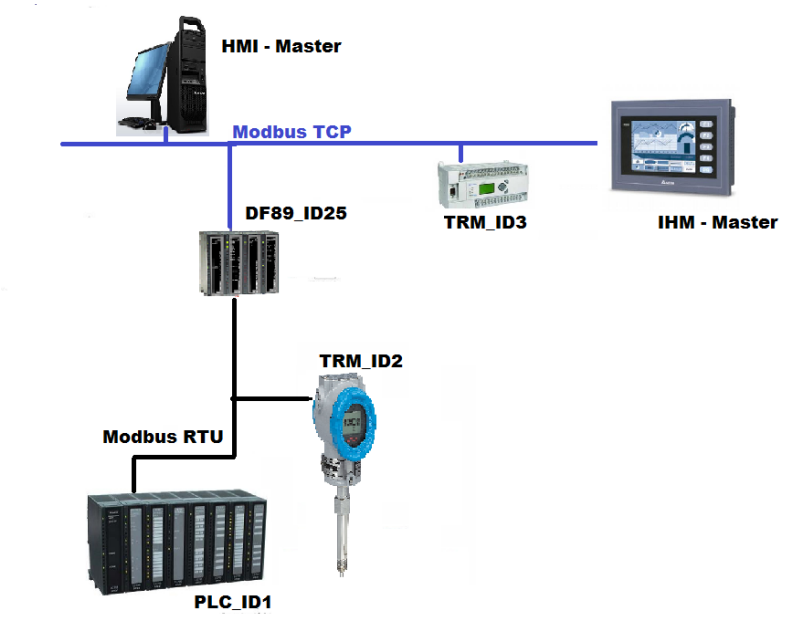


Figure 23. 1 – Example of process using several Modbus scenarios with the DF89

The configuration for each one of these scenarios is explained step by step on the next topics. At the beginning, the steps 1 to 4 are the same for all scenarios. Beyond step 5 there will be differences according to the scenario.

SYSTEM302 enables to execute the control logic by two ways: ladder or function blocks. Steps 5 to 8 are necessary to configure the Modbus network. Step 9 shows how to map the Modbus network points in available points for use in Ladder or Function Block logic. Step 10 shows how to make the configuration using ladder logic and the step 10' using function blocks. It also possible to combine both configurations, i.e., part in ladder and part in function blocks.

IMPORTANT
Before configuring the Modbus network it is necessary to previously seek information on each slave device configuration such as communication rate, data type, point address and functions supported. This information is supplied by the respective Modbus device manufacturer

Creating a Basic Area

This topic will show how to create a basic DF89 area to be used on any of the above scenarios.

Step 1

To create a new area (on the SYSTEM302 language), right-click inside the **Studio302 Areas** window and choose **New Area** as on the next figure.

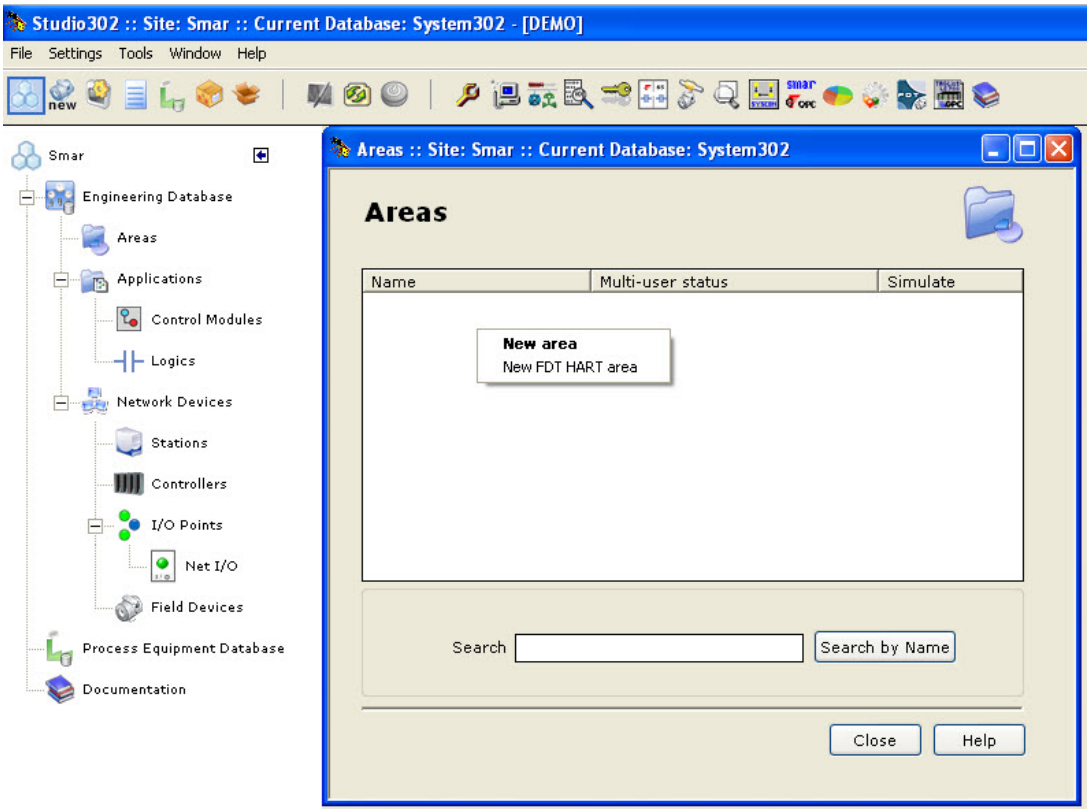


Figure 23. 2 - Options to create a new area on the Studio302

Next, a window will be shown for the user to choose the type of configuration. As the DF89 controller is HSE device, you may choose **HSE Area** or **Predefined** by using a template.

The next window will show the types of existing templates. For every controller there are options with the FFB1131 block or without it. Here, a DF89 template will be used with the FFB1131.

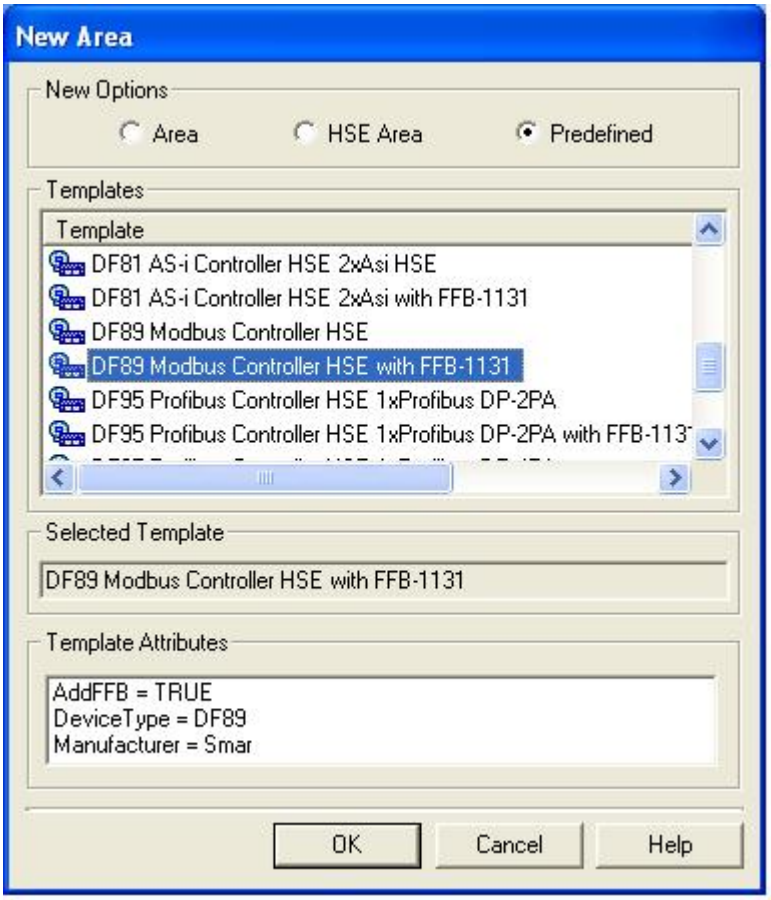


Figure 23. 3 - Pre-defined configuration window

Choose the template and click **OK**.

Step 2
The user must enter the area name as shown on the figure below.

Figure 23. 4 – New area name

Type the name **PROJ_DF89** in the **Area Name** field and click **OK**. Thus, the new area will be created with the DF89 controller. See the following figure.

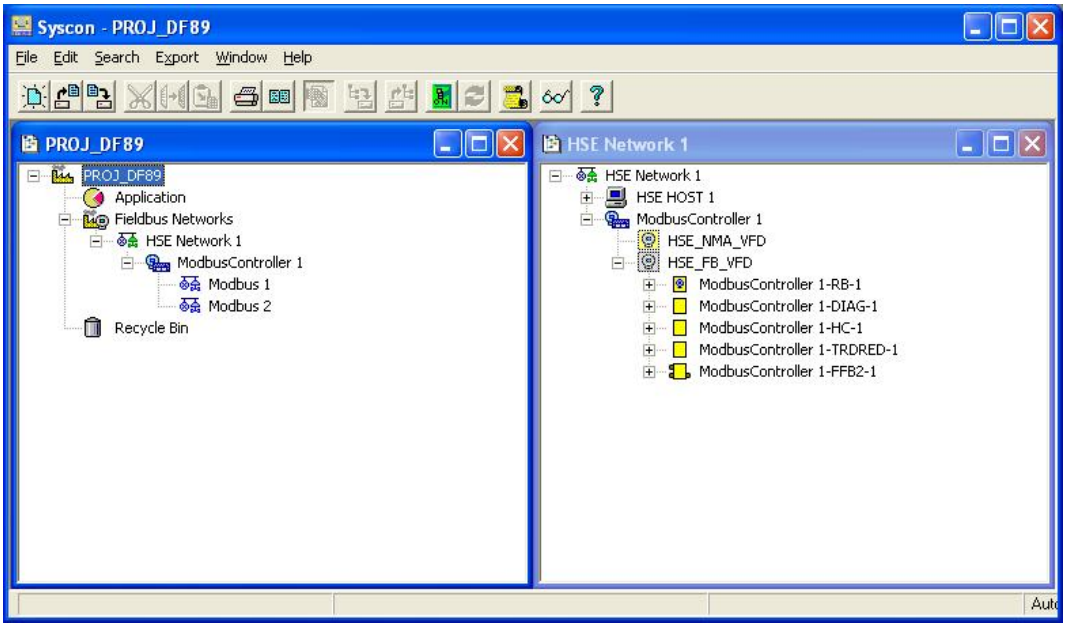


Figure 23. 5 – Syscon with the area and HSE channel windows

The figure above shows the **Syscon** window, with the HSE fieldbus network on the left (**HSE Network 1)**; below it, there is only one DF89 controller with default tag (**ModbusController 1**). Below the DF89 controller, two channels were created supported by this device: the **Modbus 1**, which corresponds to the serial channel, and the **Modbus 2**, which corresponds to the TCP channel.

The second window on the right represents the expansion (or view) of the HSE channel, which has only the **ModbusController 1.** The other HSE controllers can be added by simply clicking the channel and ask for adding new devices.

Step 3
These default tags can be altered simply by right-clicking the corresponding tag on the main window and choose **Attributes**. The figure below shows the DF89 tag altered to **Area1_DF89.**

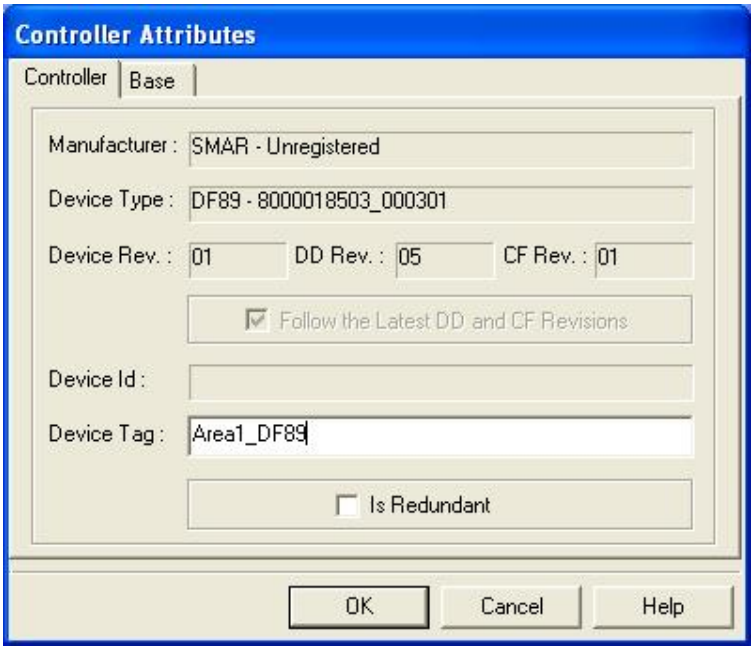


Figure 23. 6 – Controller attribute window

To alter the channel tag, on the main window, click the channel (for example, Modbus 1) and command window expansion. A new window will open. At the window edge, right-click the channel tag and choose **Attributes**. The figure below shows the configurations for the controller and the channels with the new tags. The tags were changed as follows:
HSE– from **HSE Network 1** to **Area 1 Canal HSE**
DF89 Modbus Serial – from **Modbus 1** to **DF89 Modbus RTU**
DF89 Modbus TCP – from **Modbus 2** to **DF89 Modbus TCP**

To ease the visualization, the **Details** button on the toolbar shows the type of object between brackets { }: channel, controller, and block. The figure below shows the new tags with the respective types.

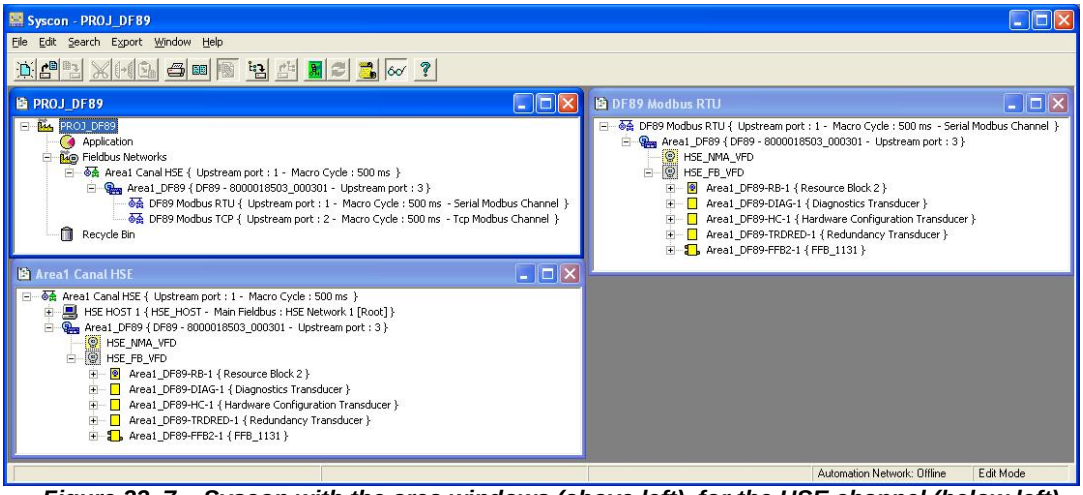

Syscon - PROJ_DF89
File Edit Search Export Window Help
PROJ_DF89
PROJ_DF89
Application
Fieldbus Networks
Area1 Canal HSE { Upstream port : 1 - Macro Cycle : 500 ms }
Area1_DF89 { DF89 - 8000018503_000301 - Upstream port : 3 }
DF89 Modbus RTU { Upstream port : 1 - Macro Cycle : 500 ms - Serial Modbus Channel }
DF89 Modbus TCP { Upstream port : 2 - Macro Cycle : 500 ms - Tcp Modbus Channel }
Recycle Bin
DF89 Modbus RTU
DF89 Modbus RTU { Upstream port : 1 - Macro Cycle : 500 ms - Serial Modbus Channel }
Area1_DF89 { DF89 - 8000018503_000301 - Upstream port : 3 }
HSE_NMA_VFD
HSE_FB_VFD
Area1_DF89-RB-1 { Resource Block 2 }
Area1_DF89-DIAG-1 { Diagnostics Transducer }
Area1_DF89-HC-1 { Hardware Configuration Transducer }
Area1_DF89-TRDRED-1 { Redundancy Transducer }
Area1_DF89-FFB2-1 { FFB_1131 }
Area1 Canal HSE
Area1 Canal HSE { Upstream port : 1 - Macro Cycle : 500 ms }
HSE HOST 1 { HSE_HOST - Main Fieldbus : HSE Network 1 [Root] }
Area1_DF89 { DF89 - 8000018503_000301 - Upstream port : 3 }
HSE_NMA_VFD
HSE_FB_VFD
Area1_DF89-RB-1 { Resource Block 2 }
Area1_DF89-DIAG-1 { Diagnostics Transducer }
Area1_DF89-HC-1 { Hardware Configuration Transducer }
Area1_DF89-TRDRED-1 { Redundancy Transducer }
Area1_DF89-FFB2-1 { FFB_1131 }
Automation Network: Offline
Edit Mode

Figure 23. 7 – Syscon with the area windows (above left), for the HSE channel (below left) and for the serial channel (above right).

IMPORTANT
Not all characters are valid when naming the elements. The valid characters are: A-Z a-z 0-9 # { } [ ] ( )+ - The invalid characters are: ~ ` ! @ # $ % ^ & * = | : ; , . < > ? / ' " \

ATTENTION
The easier method to create a configuration was used here, based on template. In this case, the configuration is created with all of the necessary channels. If the user does not want a specific channel, it can be excluded. There is another way of creating the configuration, when the controller and the channel are created manually. In this case, in the step 1 in the figure 23.3, the type of area to be chosen must be the **HSE Area** option, and only an empty HSE configuration will be created. Step 4 described below shows how to create a configurator starting from HSE window. For more details refer to the **Syscon** manual. The option to create from a template will only be available for new areas.

Step 4

This step will only serve to add a new controller or when the configuration is created only with the HSE Host. In the example of this chapter is not even necessary step.

To add the DF89 controller, at the HSE channel window, right-click the **Area1 Canal HSE**, choose **New Controller** and then **D89**, as shown on the next figure.

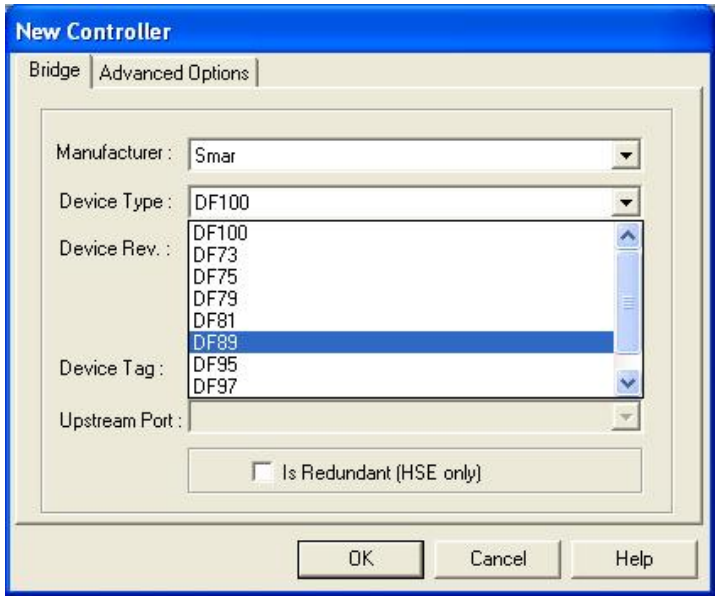


Figure 23. 8 – Creating the DF89 Controller manually

The new controller will be added. Then, still on the area window right-click and choose **New Network**. The window shown on the figure below will appear. Fill out the channel type and tag. Click **OK** and **SmarNetCont** will open automatically.

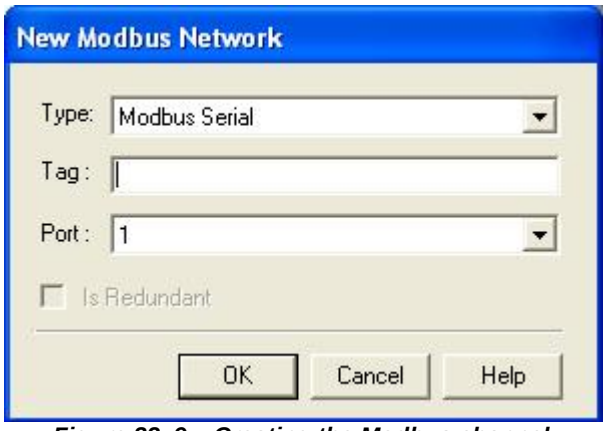


Figure 23. 9 – Creating the Modbus channel

DF89 configuration as Modbus Serial Master

This section will detail every step to make the following configuration:
- Add devices on the DF89 serial channel
- Add Modbus points on the devices
- Map the Modbus points for the **SYSTEM302** logic

For the example of the process on figure 23.1 are used one PLC slave (PLC_ID1) and one transmitter (TRM-ID2) connected to the RS-485 of the DF89 using Modbus RTU.

IMPORTANT
On the Modbus serial scenario the DF89 has two physical means, RS-232 and RS-485, although only the DF89 has a serial port. In other words, it will work only with the configuration (baud rate, stop, parity and timeout) for both means. The DF89 supports up to 32 devices on the serial channel.

Step 5

Modbus network configuration

SmarNetConf or **Network Configurator** is the Modbus network configuration tool. On it, the user will define the network parameters, all slaves that compose them and all parameters necessary for Modbus communication. The **SmarNetConf** has only the vision of the respective channel (Serial or TCP), meaning that on the serial channel vision only the device corresponding to the chosen channel will be shown.

Whenever the user needs to configure the DF89 channel as **Modbus Master** he should use **SmarNetConf.** This will be possible on the following cases:

- The DF89 is master of Modbus RTU slaves on the serial channel (RS-232/RS-485);
- The DF89 is bypass of devices on the serial port;
- The DF89 is master of Modbus RTU slaves on the TCP channel (ETH1);

More details will be provided on the respective scenario section. For other information on the **SmarNetConf** consult the tool help.

To launch the **SmarNetConf** first expand the channel window, which in this example is **DF89 Modbus RTU** serial channel. Select and right-click it. Choose the **Modify Configuration** option. See the next figure.

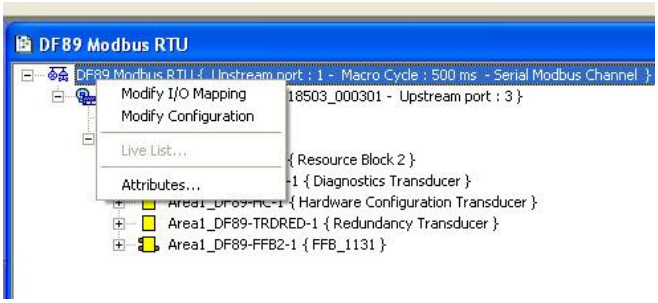

DF89 Modbus RTU
DF89 Modbus RTU { Upstream port : 1 - Macro Cycle : 500 ms - Serial Modbus Channel }
Modify I/O Mapping
Modify Configuration
Live List...
Attributes...
18503_000301 - Upstream port : 3 }
{ Resource Block 2 }
-1 { Diagnostics Transducer }
{ Hardware Configuration Transducer }
Area1_DF89-TRDRED-1 { Redundancy Transducer }
Area1_DF89-FFB2-1 { FFB_1131 }

Figure 23. 10 – Launching SmarNetConf to configure a Modbus Serial device

The figure below shows the main **SmarNetConf** serial channel window.

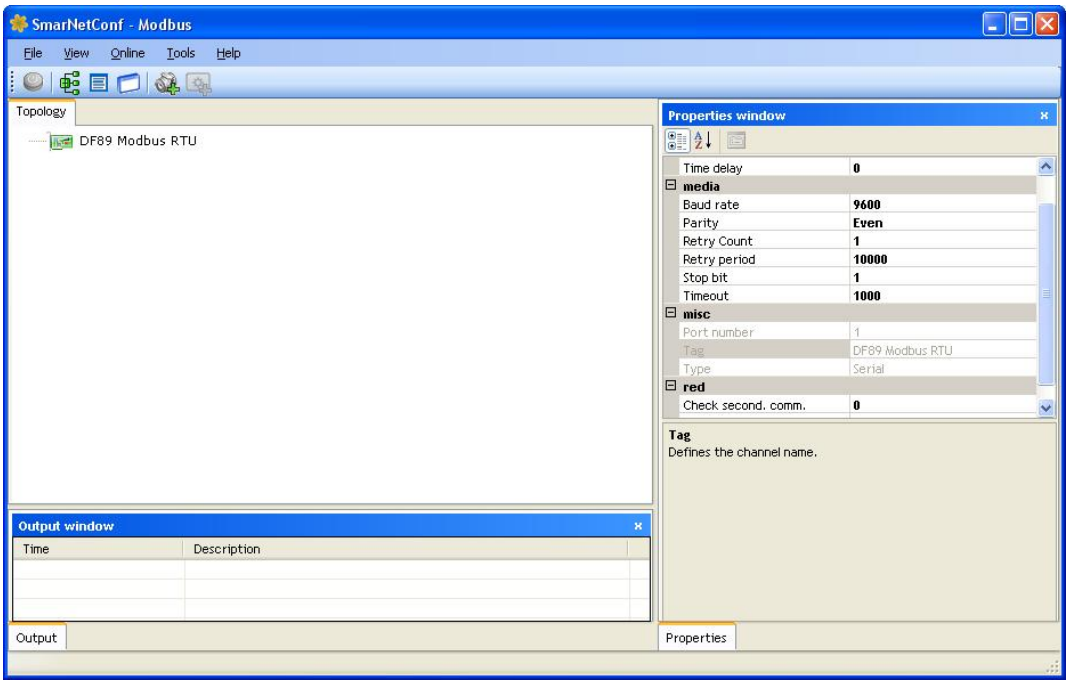


Figure 23. 11 – Main window of the SmarNetConf Modbus configurator

The configurator has three main windows as shown on the previous figure: the **Topology** window, at left, which shows a tree structure for the network device at a given channel, the **Properties** window, at right, which shows all the properties of the item selected on the topology window and, finally, the **Output** window (for events and error logs) at the bottom part of the window.

The properties channel window must have the channel parameters filled out: Baud rate, stop bit, parity, timeout, etc. Each one of these parameters is detailed on the **SmarNetConf** parameterization section.

NOTE
All devices must have the same media parameterization (*Baud rate*, *Stop Bit* and parity). The DF89 always considers the data bits parameter equals to 8.

Step 6

Configuring Modbus devices

After creating the Modbus network, the device should be configured. To insert a slave device, click on the **Insert Device** button located on the toolbar, or through the **Insert→Device menu**. The next figure shows the window to insert the slave devices, where the user can add one of several devices of the same type.

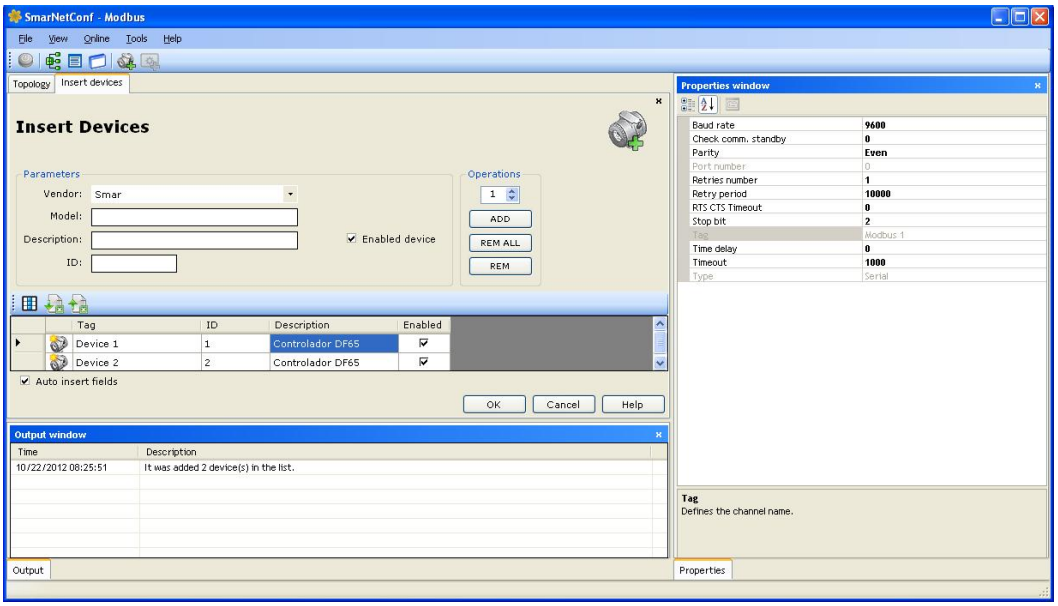


Figure 23. 12 – Adding device on the Modbus network

In this window, select the slave device to be inserted. For the present example, two serial channels will be included. First, get the information for configuring the slave device (see its manual). Follow the steps below to insert the slave device:
A. Fill out the device **Model**, **Description** and **ID** fields:
B. Select the quantity of device of a given type;
C. Click **Add**. A table will be shown with amount of selected device;
D. On the **ID** field, attribute an address for the device;
E. On the **Tag** field, the device tag is attributed. In case the user does not attribute a tag to the device, a default tag will be attributed;
F. Click **OK**. The added devices will be included on the main window.

NOTE
The attributed device addresses and tags must be the only ones in the Modbus network and also in the **Sudio302** (Workspace) database. For more details refer to the **Studio302** manual.

Both devices on the proposed example (PLC_ID1 e TRM_ID2), on the serial channel, will be shown on **SmarNetconf**. See the next figure.

Step 7

How to edit the devices properties

After adding the device, its properties can be changed. The main ones are tag, ID and if the device is or is not enabled. Other properties can be changed in this window. An explanation for each property is shown on the **SmarNetConf** parameters section.

For example, to edit the PLC_ID1 properties, right-click the corresponding Modbus device. At the open pop up, choose the **Edit Device Properties** option to configure the slave device parameters.

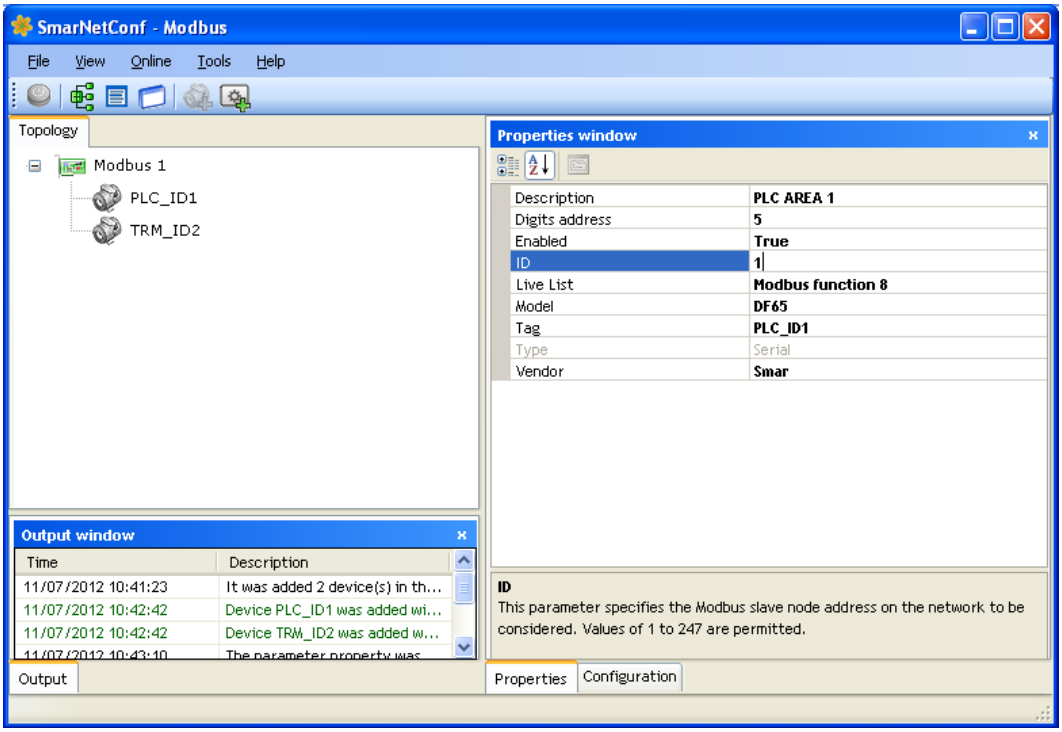


Figure 23. 13 – Editing the device properties

Step 8

Adding commands to the device

The slave variables to be supervised or written are mapped by commands, which can be individual or multiple ones. For example, if the analog points should be supervised on addresses 40001 and 40010. This supervision can be performed through the two individual commands (cmd1 for 40001 reading and cmd2 for 40010 reading) or a multiple command (cmd1 –reading beyond 40001 reading with 10 registers). This last form is most common and most optimized.

The command configuration window is accessed right-clicking the corresponding Modbus device, for example, the PLC_ID1. On the open pop up, choose the **Insert Commands** option to configure the device Modbus commands. The following figure shows the example of a command addition window.

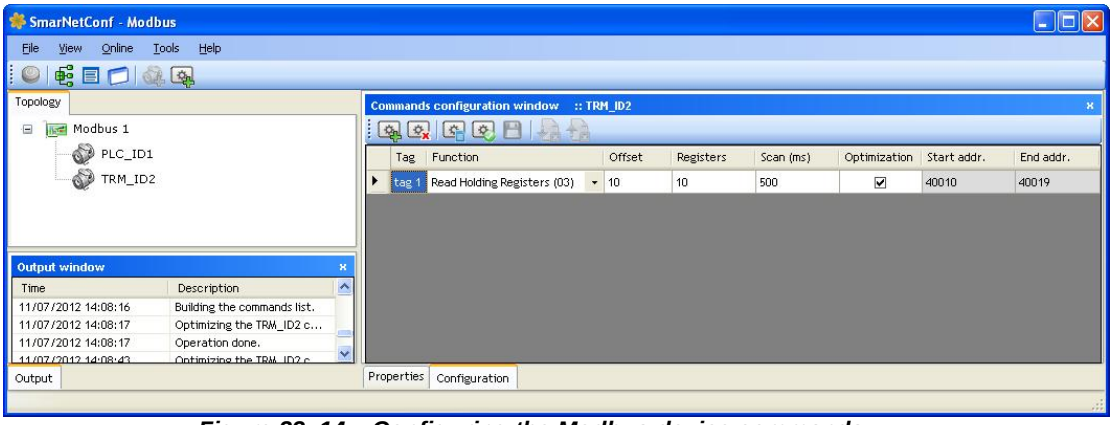


Figure 23. 14 – Configuring the Modbus device commands

The commands configuration window on the above figure shows a toolbar in which it is possible to add, delete, check if the configuration is correct, save the configuration, import and export to a xls format spreadsheet. More information about these features refers to the **SmarNetConf** help**.**

For each new command, it is created a table line up to the limit of 30 commands per device. On the Modbus protocol the addressing takes into account the functions, the offset and number of registers. Hence, for each command, the user should pay attention to the mapping of these three parameters. The detailed command description is shown on the next **SmarNetConf** parameter section.

The DF89, when working as master, admits the Modbus functions shown on the table below. At the "data type" column RW means that it supports reading and writing and RO supports only reading.

Modbus Function	Description	Data Type
1	Read Coils (0x)	Discrete Input (RW)
2	Read Discrete Inputs (1x)	Discrete Input (RO)
3	Read Holding registers (4x)	Analog Input (RW)
4	Read Input registers (3x)	Analog Input (RO)
5	Write Single Coil (0x)	Discrete Output
6	Write Single Register (4x)	Analog Output
15	Write Multiple Coils (0x)	Discrete Output
16	Write Multiple Registers (4x)	Analog Output

Table 23. 1 – Modbus Functions Supported

After including the command check the configuration and save it. This saving indicates that every device configuration command made on the SYSTEM302 database will be effective. In order for this to happen there can be no inconsistencies on the commands mounted (like the inclusion of repeated points on the commands or a command bigger than the limit. This is done by the **Check** and **Save** buttons in the **SmarNetConf** toolbar.

The ***Scan*** and ***Optimization*** fields are advanced parameters that can remain as **Default**. The **Scan** field indicates the minimum time desired between the scan on the respective command. The **Optimization** field indicates that the Modbus command is to be optimized or not. The latter, if the user chooses not to optimize it, will be activated the same way it was configured.

Finally, the **Start Address** and **End Address** fields are ways to visualize the Modbus points. The **Start Address** represents the beginning of the Modbus range addressed, while the **End Address** represents the end of that command. This type of visualization can be of 5 digits (under the Modbus Modcon specification) or 6 digits (under a Modbus 2.0 spec). The device **Digits Address** property indicates if the visualization will be with 5 or 6 digits.

For example, on figure 23.13 a visualization of 5 digits was used. The first command was mapped as follows: analog reading "03" function, offset equal to 10 and number of registers equal to 10. This represents the addressing of the Modbus 40010 to 40019 registers. Should the chosen visualization be that of 6 digits, so the corresponding Modbus **StartAddress** addresses would be 400010 and the **EndAddress** would be 400019.

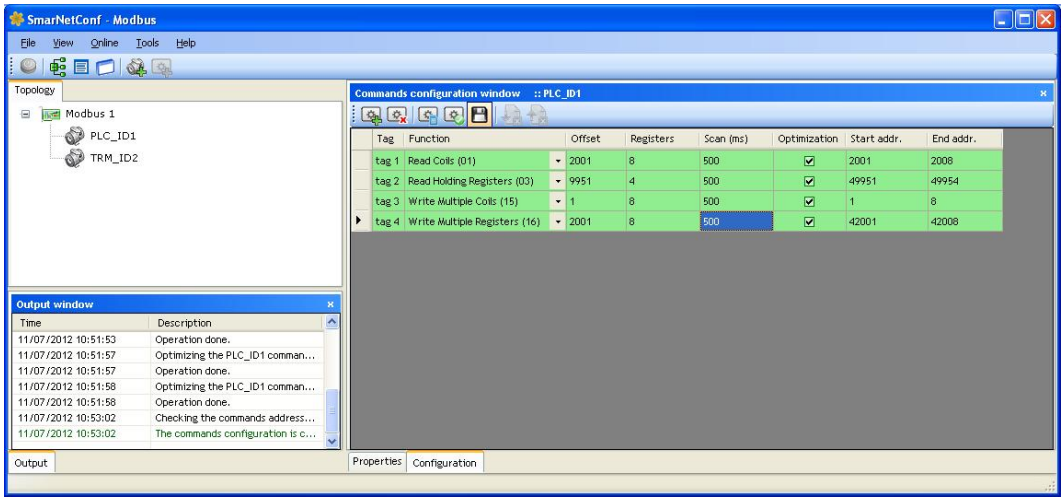

SmarNetConf - Modbus
File View Online Tools Help
Topology
Modbus 1
PLC_ID1
TRM_ID2
Commands configuration window :: PLC_ID1
Tag Function Offset Registers Scan (ms) Optimization Start addr. End addr.
tag 1 Read Coils (01) 2001 8 500 2001 2008
tag 2 Read Holding Registers (03) 9951 4 500 49951 49954
tag 3 Write Multiple Coils (15) 1 8 500 1 8
tag 4 Write Multiple Registers (16) 2001 8 500 42001 42008
Output window
Time Description
11/07/2012 10:51:53 Operation done.
11/07/2012 10:51:57 Optimizing the PLC_ID1 comman...
11/07/2012 10:51:57 Operation done.
11/07/2012 10:51:58 Optimizing the PLC_ID1 comman...
11/07/2012 10:51:58 Operation done.
11/07/2012 10:53:02 Checking the commands address...
11/07/2012 10:53:02 The commands configuration is c...
Output
Properties Configuration

Figure 23. 15 – Configuring the PLC_ID1 commands

When the previous steps are finished, the Modbus channel configuration can be saved and the **Smar Network Configurator** can be closed. Automatically the **Mapping Tool** launches**.**

Do not forget to save the commands configuration before exiting the **Smar Network Configurator.** This is the only point to be saved manually. The changes of the properties on the channel or the device are saved automatically.

Step 09

Mapping the Modbus points for the SYSTEM302 logic

The **Mapping tool** is responsible for mapping the Modbus network points on points available for use in Ladder Logic or Function Blocks logic. This tool also configures all the features of the Modbus network points (user tags, data types, scales, etc.). Observe the next figure:

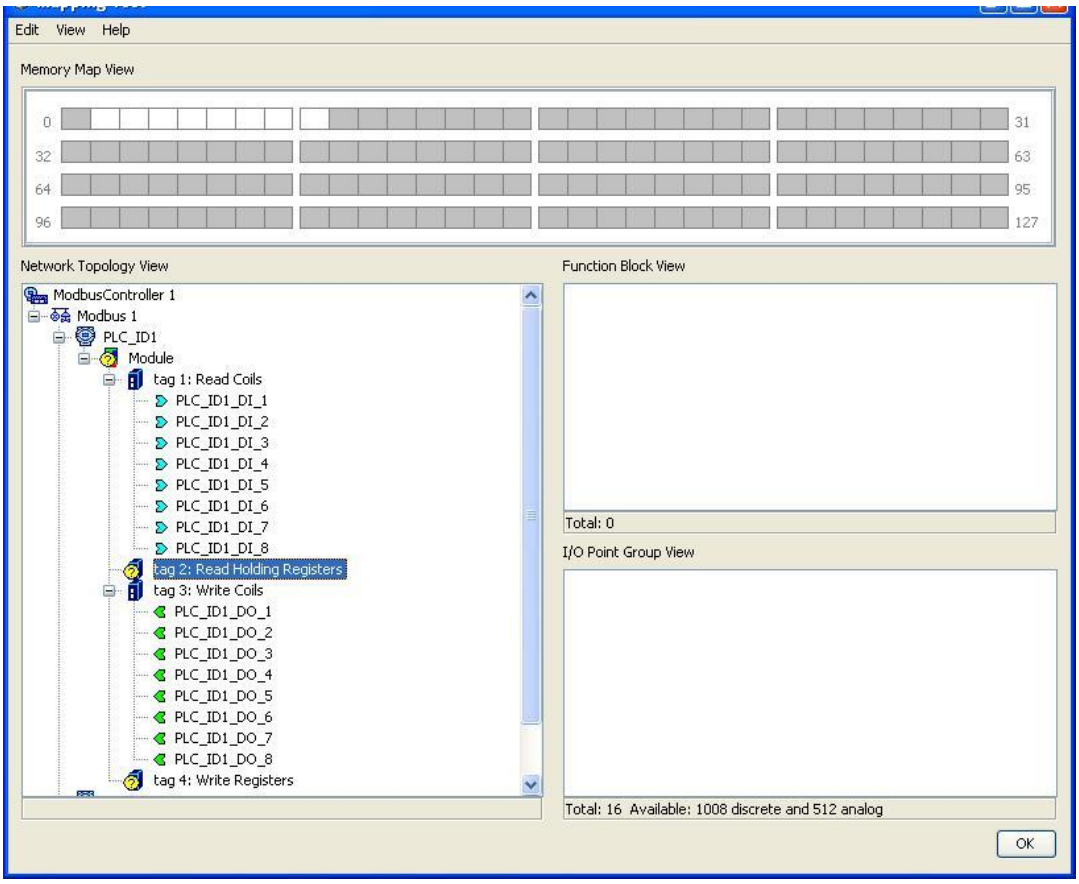


Figure 23. 16 – Mapping Tool window

As seen on the previous figure, the device was inserted on the Modbus network with their respective commands. The **Function Block Label** shows the points that will be visualized on the **Syscon** and on the **IO Point Group View** window are shown the points to be seen on the **LogicView for FFB.** The purpose here is to configure each network point (or byte) at their respective data type.

A **Mapping Tool** maps automatically by default all registers created on the **SmarNetConf** with discrete functions (Modbus 1, 2, 5, 15 functions) as Boolean type. The user can only alter the point tags. The analog points that appear with the symbol must be configured.

To configure the point, click the command to be configured; on the next figure, for example, the command will be **Tag2**. Remember that on the **SmarNetConf**, **Tag2** was mapped on the Modbus from 49941 t9 49954 register range.

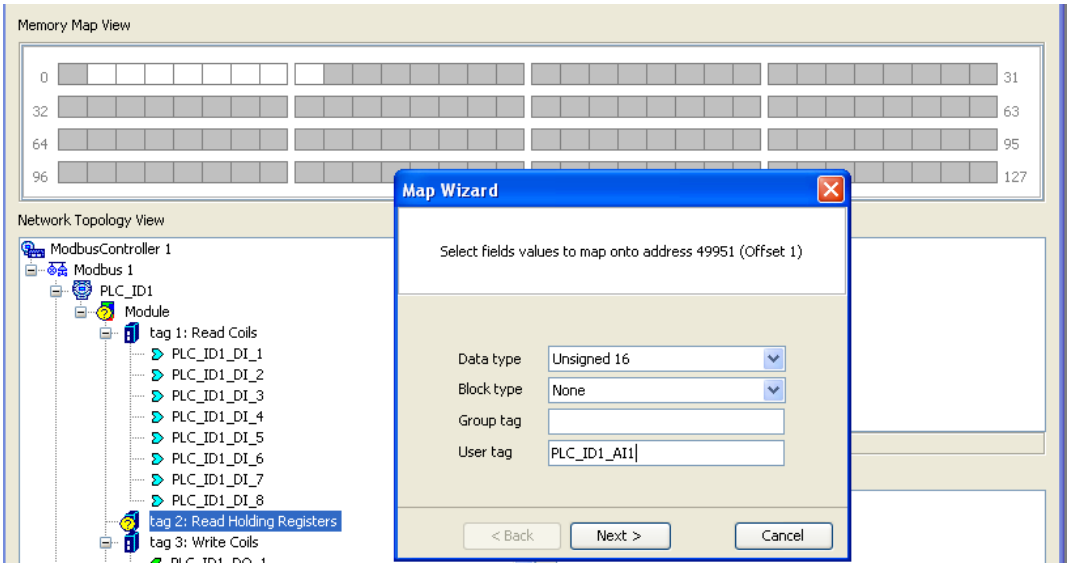


Figure 23. 17 – Mapping the analog points on Mapping Tool

On the window upper part, the available bytes will be shown in white. Click the byte and a window to configure the point will appear. For our example on **Tag2** the first available byte was clicked. According to the mapping window it corresponds to the 49951 address (Byte Offset 1).

Choose the data type (**Data type**) of the slave device variable. The available types depend on the chosen device and must be obtained in the slave device manual. For our example of the data type of the point 49951 is **Unsigned16**. For analog points can also be set for each scale point. More information about Data type will be shown in the Advanced Topics section. The figure below shows the configuration of the point scale.

Figure 23. 18 – Configuring the scale parameters

By right-clicking the point you can remove it with the **Delete** option, or define some attributes that identify it better, with the **Attributes** option. The **Mapping tool** automatically creates the description with the Modbus address. This is useful to identify the point through the Modbus address in the ladder logic. Fill out the necessary fields and click **OK**.

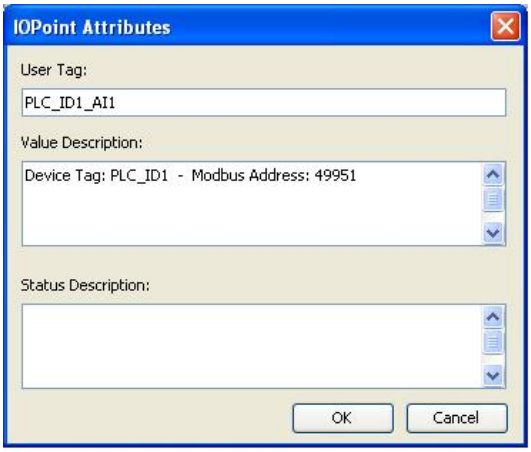


Figure 23. 19 – Altering the attributes of the mapped points

It is still possible to choose between the data on the direct or swapped format for analog types with 4 bytes (float, uns32 and signed32). This device information tells if it uses data with the swapped format or not. To configure the swapped format, right-click the device on **Mapping tool** and choose **Swapped**, as shown on the figure below. The Advance Topics section explains in detail the type of swapped data.

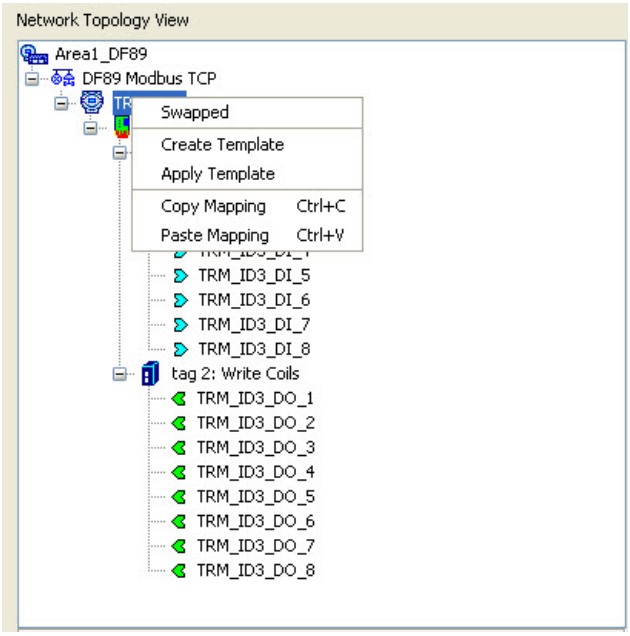


Figure 23. 20 – Example of configuration

After mapping and configuring all points, click **OK** to close the **Mapping Tool**.

Save the configuration after returning to the **Syscon**.

DF89 Configuration as Modbus TCP Master

This section will detail all steps to make the following configuration:

a. Add devices on the DF89 TCP channel
b. Add Modbus points on the slaves
c. Map all Modbus points for the **SYSTEM302**

As an example of the figure 23.1 process, the Modbus TCP Master configuration uses the PLC_ID3 slave transmitter.

To configure the Modbus TCP channel, the procedure is the same used on the serial channel from step 5, where the Modbus TCP also is the **SmarNetConf**. To that effect, choose the Modbus TCP as channel type on the figure 23.7 window and expand the TCP channel. From the area window expand the TCP channel (DF89 Modbus TCP). Select the channel on the window top and right-click it. Choose the **Modify Configuration** option.

The figure below shows the TCP channel main **SmarNetConf** window.

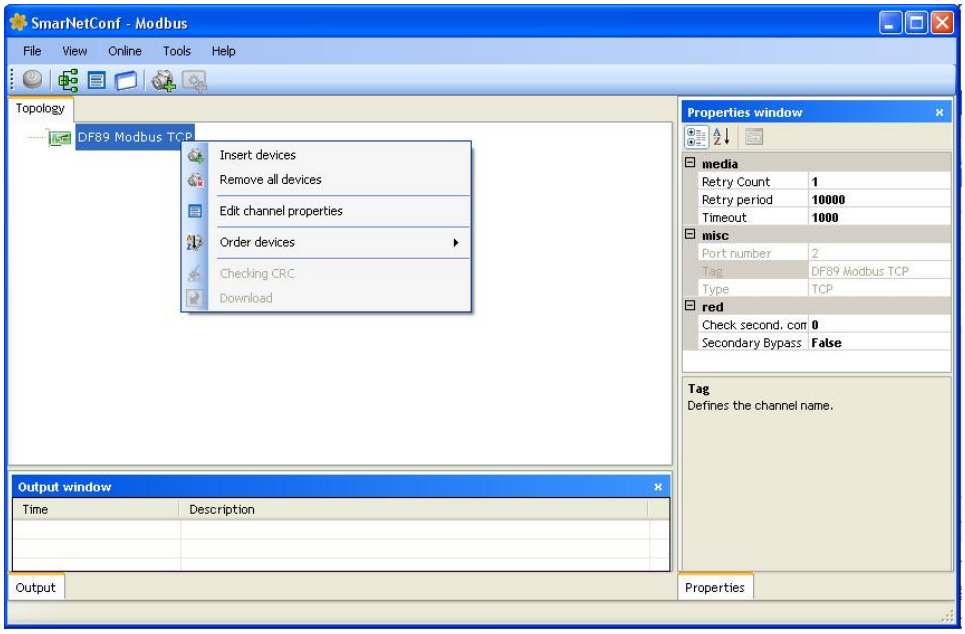


Figure 23. 21 – SmarNetConf Modbus Configurator main window

The CHECK SECOND. COMM. parameter has similar functionality of CHECK_COMM_STANDBY paramater of MBCF block that is used by other DFI302 controllers. So the secondary DF89 (standby) will perform a communication test with the slave devices in the period configured in this parameter.

Configuring the Modbus devices

To insert a slave device, click the **Insert Device** button located on the toolbar, or through the **Insert→Device** menu, or still right-clicking the TCP channel as shown on the next figure. The window shown on the next figure is the window for slave device insertion where the user can add one or several devices of the same type.

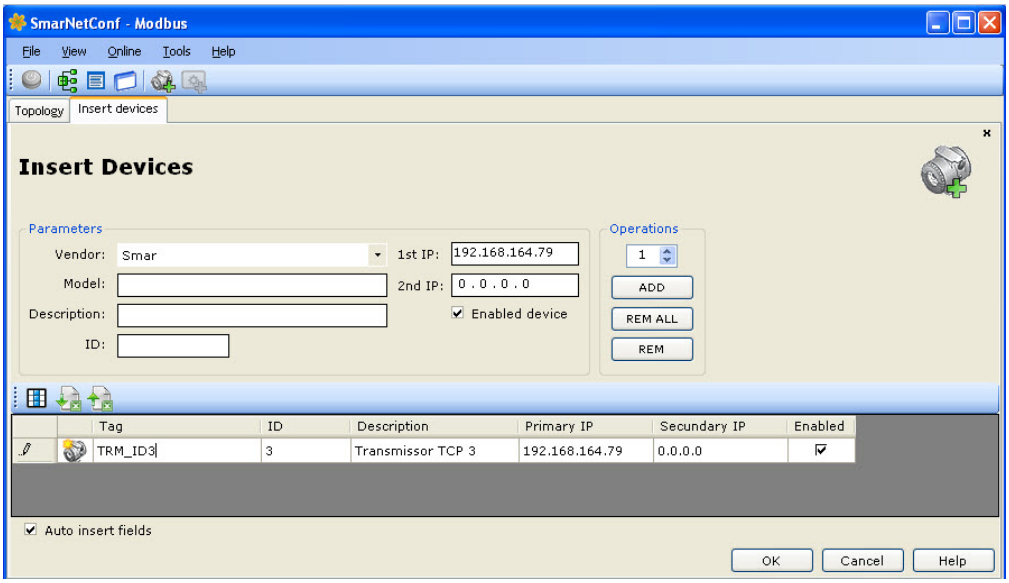


Figure 23. 22 – Adding device on the Modbus network

Select on this window the slave device to be inserted. One device only will be included on the proposed example. First, get the slave device Modbus configuration on its manual. Follow the steps below to insert the slave device:

A. Fill out the **Model, Description** and **ID** of the device**;**
B. Fill out the device IP address on the **1st IP** field. If the device is redundant, the **2nd IP** will be chosen as redundant path. For more details see the Redundancy section;
C. Select the device quantity of a determined type. In this case it will be only one.
D. Click **ADD**. A table will be shown with the quantity of selected device.
E. On the **ID** field, attribute an address for this device.
F. On the **Tag** field is attributed the device tag. If the user does not attribute a tag, a default tag is attributed.
G. Click **OK**. The added device will be included on main window.

NOTE
The addresses attributed, as well as the device tags must be the only ones on the Modbus network and also on the **Studio302** Workspace database. Refer to the **Studio302** manual.

Editing the devices properties and commands

After adding the device, its properties can be changed. To alter the device properties, add and delete commands, follow the same procedures described for the serial channel. The device properties and commands are described in detail on the SmarNetConf Parameters section.

For the TCP channel example there is a TRM_ID3 device. The following figure shows the **SmarNetConf** screen with the **TRM_ID3** device of the proposed example.

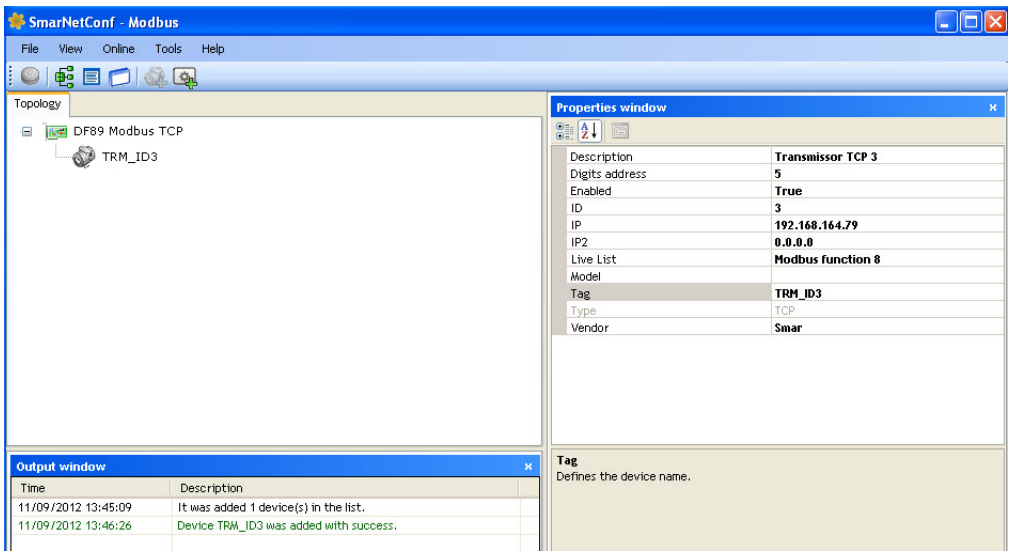


Figure 23. 23 – Example of the TCP channel properties

Making logic with the Modbus I/O Points

This section will detail all steps to make the following configurations:

a. Make a logic in blocks or ladder with the slave Modbus points
b. Download the configuration.

Until now the Modbus TCP and Serial slaves were created and their points were mapped. The next steps will show how to use the points mapped on the **Network Configurator** for the control logic. As mentioned previously, there are two ways to map inputs and outputs on ladder logic or function blocks. Each tool has its specific block library. It is possible to blend both logics through the FFB 1131 block.

Initially the steps will be shown to use only the Ladder logic. After that, it will be explained how to mount the logic using function blocks. Which tool to use will be user´s choice.

Mapping the Modbus points to be used on Ladder

Step 10

As the points will be mapped to be used on ladder, by returning to the figure 23.17, it is not necessary to use the **Block Type** option (None). A tag can be attributed to the group on the **Group Tag** option or leave the default tag (**Group Tag** is important for use in blocks). Finally the **User Tag** to be shown on the ladder logic will be chosen. In our example the 49951 point will be **PLC_ID1_AI1** as seen on figure 23.25.

Sometimes, especially when the **LogicView for FFB** is already open, the points mapped on the **Mapping Tool** do not appear on **LogicView for FFB.** If so, execute the **Refresh Data** command to update the I/O points configured on the **Mapping Tool** on the ladder logic by right-clicking **Network I/O** at the **Hierarchy** window of the **LogicView for FFB.** See the next figure.

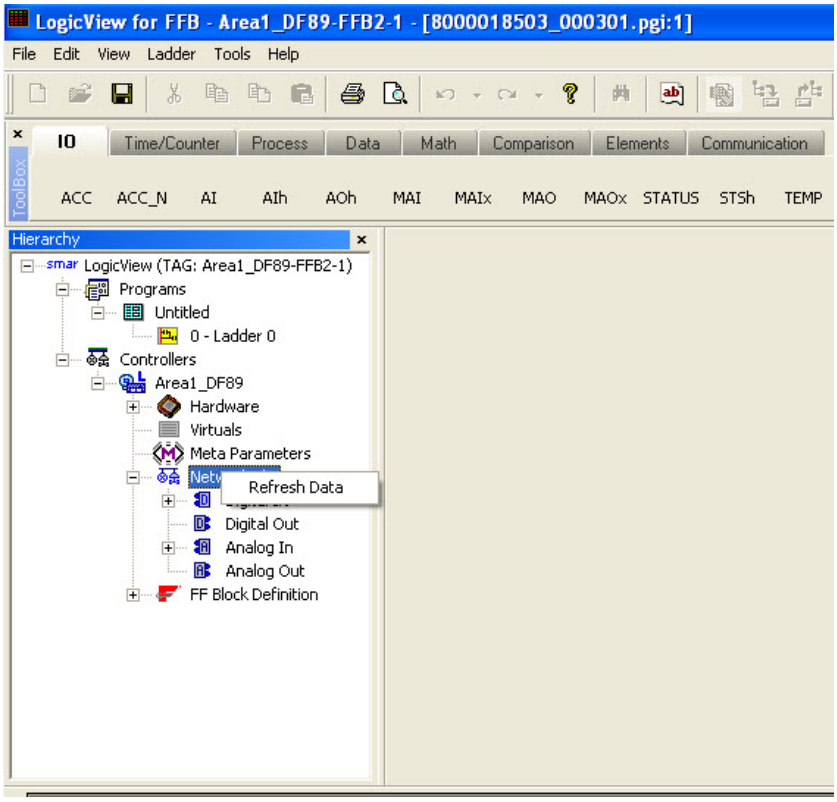


Figure 23. 24 – Executing the Refresh Data

The **NetIO** points can be seen on the **LogicView for FFB Hierarchy** window. On the **Object Properties** window is generated initially a description of the Modbus address variable. On the figure below, **Hierarchy** is on the left side window with all the Modbus points mapped on the **Mapping tool**. On the **LogicView for FFB** all points of both channels are shown. On the right side of the figure is shown the **Object properties** window of the **PLC_ID1_AI_1** selected point that was configured on the Modbus 49951 address.

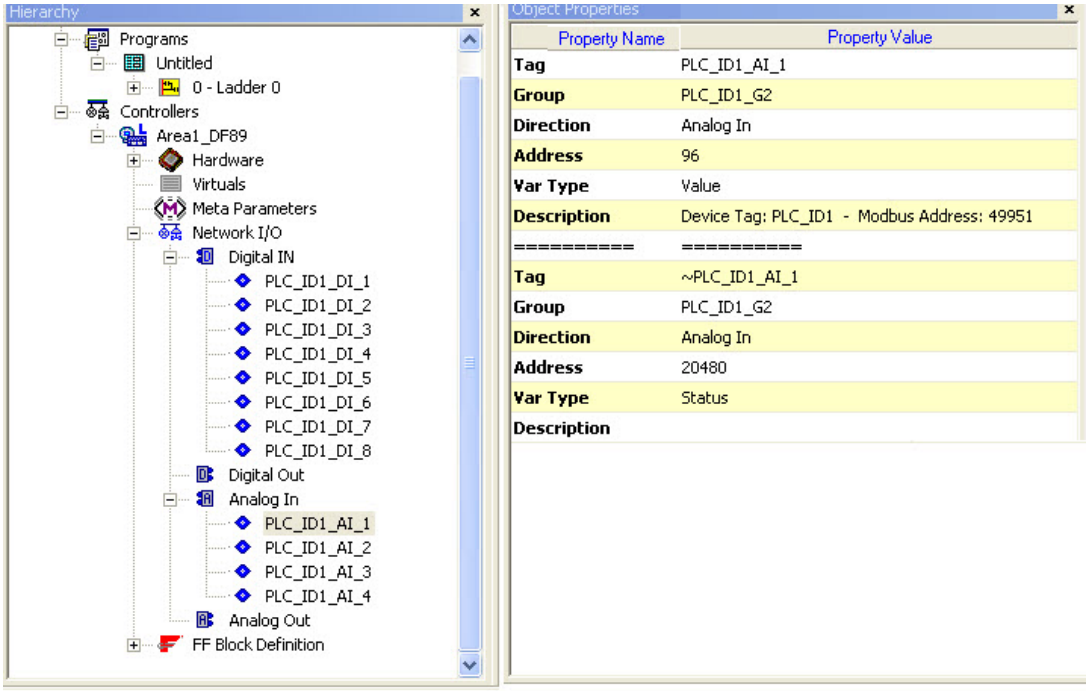


Figure 23. 25 – Network I/O on LogicView for FFB

After this procedure, the Modbus network I/O points are available to be used on the ladder logic,

counting on a complete function library to be utilized by the user. For more details see the **LogicView for FFB** manual.

The figure below shows two Modbus points used on ladder logic. The discrete **PLC_ID1_D1_1** point and the analog **PLC_ID1_AI_1** point**.** All of the Modbus I/O points appear as the **(MB)** symbol on ladder logic.

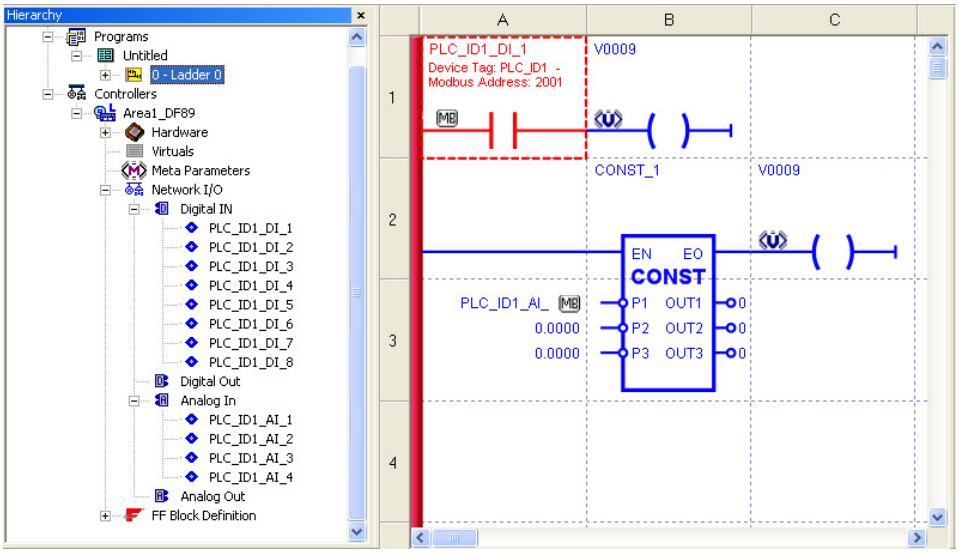


Figure 23. 26 – Editing the logic

The configuration of the serial channel using ladder logic only ends here. Save the **LogicView for FFB** and return to the **Syscon**.

After configuring the ladder, the user can download the configuration on the device, or instead choose to configure function blocks on the **Syscon**. Should the user wants to work also with function blocks, it is necessary to follow the steps 9 to 12 for the function blocks edition.

To follow the same example, it is still necessary to configure also the TCP channel. To configure the TCP channel without using function blocks go to the **Configuring TCP Channel** step. To download only the configuration up to this point, go to the **Configuration Download** step.

Step 11

Mapping the Modbus points to be used in Function Blocks

Similarly to the configuration was done through the ladder, the configuration can be done using function blocks. This section will show the mapping of the same Modbus I/O point of step 10, but now using function blocks.

As stated previously, for the creation and insertion of network devices the steps are common up to step 8. That is, we must follow the complete procedure for the area creation of **Syscon** and set the controller, as done in steps 1-4 and the devices should also be inserted in the same way as done for the ladder.

To map the I/O points in function blocks in the **Mapping Tool** window of as shown in the figure 23:17, it is necessary to fill the **BlockType** field. When is chosen **None**, as shown in step 10, indicates that the point only is mapped in the ladder.

The user can only choose to map the I/O points in function blocks of type multiple inputs (analog or discrete - MAI and MDI) or multiple outputs (analog or discrete - MDO and MAO).

At this point the user is ready to develop the control strategy. In this case the user may use other function blocks to make the desired control strategy. To interconnect the blocks the user needs to make links between them. To open a control strategy in **Syscon** is necessary to create a control module, and then, the strategies. For details on these procedures, it is recommended to check the **Syscon** manual.

An important parameter the must be configured in all function blocks is the MODE_BLK parameter that determines the Out of Service (OOS), Manual (MAN) or Automatic (AUTO) block operations. All blocks in this area must have the MODE_BLK.TARGET in AUTO. Each block has a specific parameter configuration. For more information about each block see the Function Blocks manual.

NOTE
The Modbus I/O blocks do not need to configure the CHANNEL parameter. This parameter will only work when using the I/O blocks to map the local I/O (IMB).

Commissioning and configuration download to the controller

After configuring the parameters, the user can begin communicating with the devices. It is necessary to perform the device commissioning so that each device tags, IDs and addresses be attributed adequately. If this procedure is not observed, the **Syscon** will detect the non-commissioned device and the download will be aborted. The commissioning consists in combining a network DF89 controller and the configurator used on the configuration. The same configuration tag will be attributed to the controller.

To commission, simply enable the online communication with the network equipment through the ON button on the **Syscon** toolbar shown below.

Figure 23. 27 – Enabling Online mode

Then, click the controller or the channel and choose **Commission**. More information on how to commission refer to the **Syscon** manual.

After finishing the devices commissioning, the download process may begin. Download can be done in several **Syscon** points and depends on the purpose: on all controllers, on only one controller, etc. However, the **Syscon** download is recommended for being the most complete, as it controls the alterations performed on all tools.

The **Syscon** has two download procedures: conventional mode (non-incremental) and the incremental download.

- On conventional or non-incremental download the entire configuration is downloaded on the device.
- Incremental download includes a phase that compares the configuration stored on the plant physical device with the **Syscon** configuration, stored on the **Studio302** database. Only the differences are downloaded to avoid that unnecessary information are sent to the device. On this option, the download scope can be limited by the user.

The figure below shows the device download with the option for performing the incremental download or not (which, in this case would be the total download).

Figure 23. 28 – Performing the download

The download operation can affect a network of devices (when selecting a Fieldbus network, an HSE network or a Linking Device channel) or a particular device, possibly a HSE device (Bridge, Linking Device, Controller), or a H1 device. In the latter case, the operation is also called **partial download**.

The download operation will be available only when the **Syscon** is on online mode, communicating with the plant and with the device already commissioned.

NOTE
If the user has finished the commissioning, the **Syscon** suggests a download. Sometimes, after the commissioning is performed, it is necessary to click on the **Refresh** button at the right side of the online button on the Windows toolbar.

If the user chooses the incremental download, this option must be selected in the previous window. A window will appear with the incremental download configuration options. If there are some of the selected options, it means that **Syscon** will compare initially that option with the controller and will only download if there are differences. Before downloading, the **Syscon** still will show the user a window with the differences. Only when the user verifies the differences the new configuration will be really downloaded.

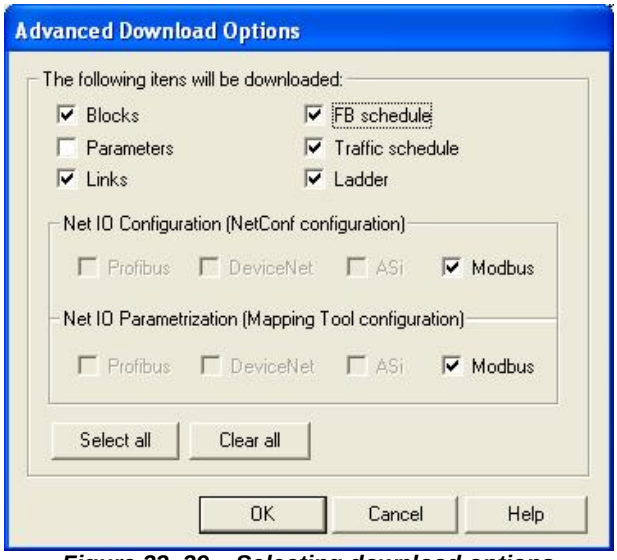


Figure 23. 29 – Selecting download options

On the present example, only **PROJ DF89** is to be downloaded. So, right-click the controller and select the **Download** option. On the download window, select **Start**.

After performing the download, the user can check the logic parameters supervision on the device. To supervise the parameters, both of ladder and blocks, the user must perform **Export Tags**. This procedure indicates that the database will be updated with the desired supervision information. **Export tags** is done on the area window by right-clicking its name.

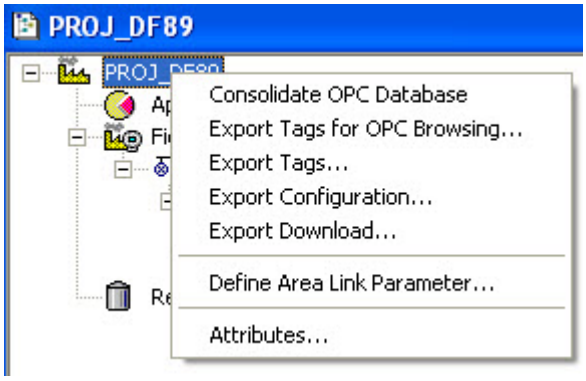


Figure 23. 30 – Performing the Export Tags

After this operation the user can supervise the configuration parameters. New ladder logic or block alterations may be applied. The **Export Tags** procedure must be repeated only if new ladder logic or block alterations are included.

DF89 Configuration as Modbus Slave

DF89 can work as Modbus Serial slave or TCP. In this case, any Modbus Master equipment can read the points on the DF89 controller, be them conventional I/O, Modbus I/O points of slaves scanned by the DF89 or other DF89 internal points. On the figure 23.1 example, the DF89 is the Modbus slave of an IHM Modbus TCP.

To configure the DF89 as Modbus slave, a block must be first created on **Syscon** - **Modbus Slave Configuration.** To that effect, right-click the **HSE_FB_VFB** of DF89 controller, as shown on the next figure.

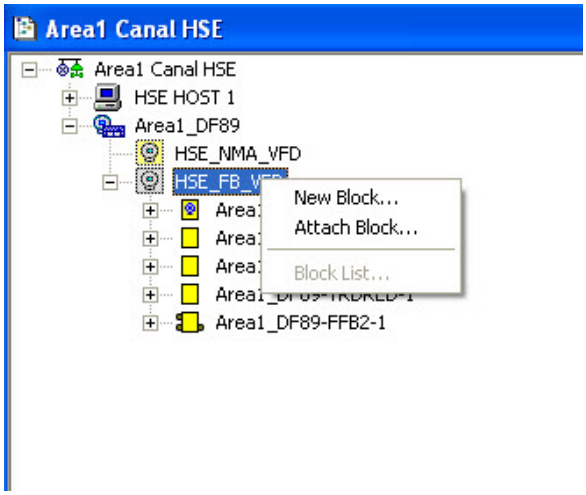


Figure 23. 31 – Including a new block on the controller

Then, a **Modbus Slave Configuration** block must be created. This block represents the entire DF89 configuration as Modbus slave (Serial or TCP).

After creating the block, the user may configure the parameters. As Modbus TCP slave the main parameters are **MODE_BLK** and **DEVICE_ADDRESS.** On figure 23.1, the DF89 has the Modbus address 25.

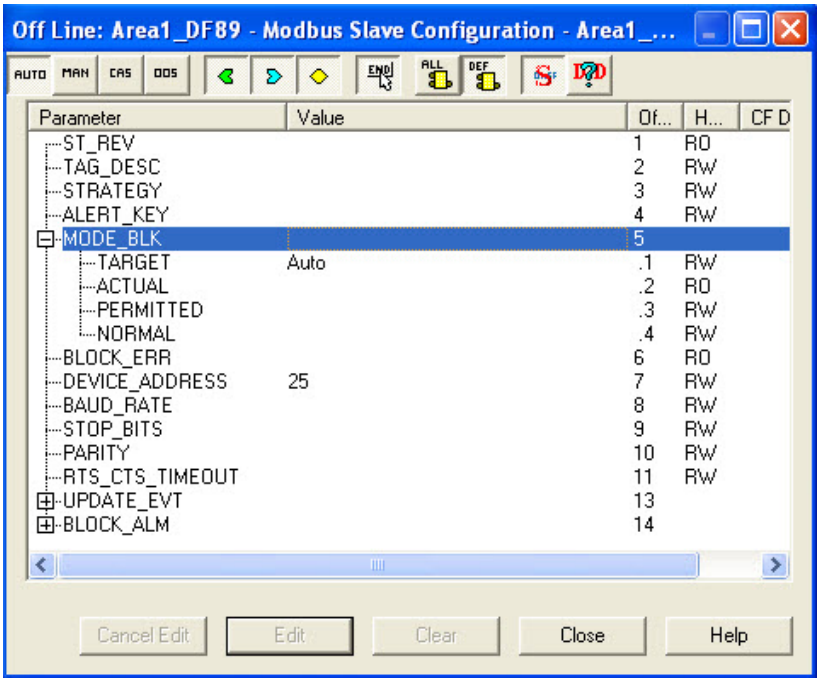


Figure 23. 32 – Modbus Slave configuration parameters

The Modbus Serial slave configuration requires the following procedure:

1) No serial channel can be created on the **Syscon**, because the DF89 has only one serial channel. The serial channel as master has priority over the slave function.
2) **MODE_BLK** and **DEVICE_ADDRESS** parameters must be configured on the **MBSCF** block.
3) Serial media parameters must be configured on the **MBSCF** block: Baud rate, Stop Bits and Parity.
4) The serial can be checked if it is enabled as slave or master on the **Modbus Transducer** block **SERIAL_CHANNEL**.

Only the points mapped on ladder logic can be mapped as Modbus slaves. Each Modbus point on ladder has a respective Modbus address. To get information about the point, click it and check the **Object Properties** window, as shown on the next figure.

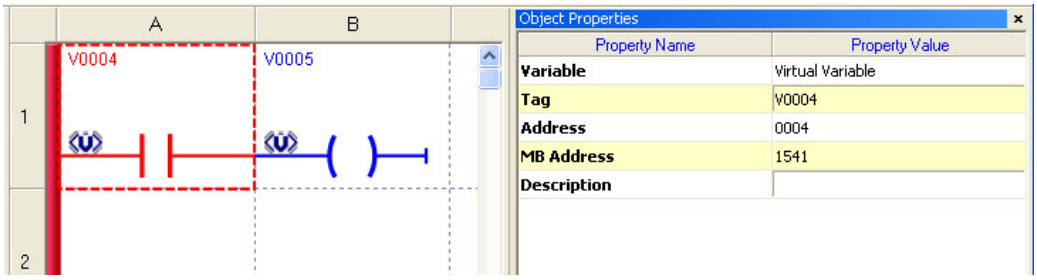


Figure 23. 33 – Example of how to get the Ladder point Modbus address

On the example of the figure above, the V0004 contact has **1541** as Modbus MB address.

NOTES
1) All analog points are floating type. 2) Only Modbus multiple writing functions are admitted, namely, functions 15 and 16. 3) The DF89 is already produced as Modbus TCP and Serial slave on address 247 with baud rate 9600/1/Even.

DF89 Configuration as Bypass Modbus only

Another DF89 feature is to work as **Bypass Modbus**, i.e. Modbus TCP master equipment can access a slave Modbus serial equipment situated below the DF89.

The DF89 configuration as bypass is done by creating a serial channel. If the user wishes to work only as bypass, simply create a serial channel on the **SmarNetConf** and configure the serial media.

On figure 23.1 example, the serial channel with devices has already been created, so it is already supporting the bypass automatically. Take as example the IDM Master TCP accessing any point of the **TRM_ID2** or **PCL_ID1** slaves simply by attributing the **ID** of the respective device (**ID 1** or **ID 2**) and the DF89 IP.

NOTES
• To work as bypass, the Modbus slave address cannot be the same as the **MBSCF** block **DEVICE_ADDRESS**. • The media configuration is done only on **SmarNetConf**. On the bypass case, the same download can be used on the modification of any media parameter. • The bypass is supported by the two DF89 Ethernet ports: ETH1 and ETH2. • On the redundancy case, it is also possible to access the secondary port as bypass, simply by configuring the parameter of the **BYPASS_SECONDARY** device on **SmarNetConf.**

Advanced Modbus topics

There are two main Modbus specifications: an old one, created by Modcon company – the predecessor of Modbus, which follows the Modcon **PI-MBUS-300** 1996 reference book. The current Modbus version follows the Modbus Organization specification – Application Protocol Specification – since 2002. Both specs are totally compatible, with only one difference of visualization and size on the addressing band.

The Modbus register is a 2-byte number (Word) that indicates a given parameter on the slave device. For example, address 1 indicates an I/O point, while address 2 indicates another I/O point. This Modbus Modcon addressing has specific ranges depending on the function shown below, taking into consideration that the Modbus protocol function indicates if it is desired working with register reading or writing. The functions supported and the description for each function are on table 23.3.

- Functions 1, 5, 15 – addressing range Modbus Modcon 0xxxx (0001 – 10000)
- Functions 2 – addressing range Modbus Modcon 1xxxx (10001 – 20000)
- Functions 3, 6, 16 – addressing range Modbus Modcon 4xxxx (40001 – 50000)
- Function 4 – addressing range Modbus Modcon 3xxxx (30001 – 40000)

For the current version, also called *extended Modbus*, this range no longer exists, since the frame format already ignore it. This kept the addressing range from being restricted to the 10000 range registers.

A favorite format to use these ranges as reference is the quantity of bytes on the Modbus address, i.e., if it uses 5 or 6 digits. The table below compares old and new addressing as address examples.

EXAMPLE OF USER INPUT		VIEW 5 DIGITS	VIEW 6 DIGITS	MODBUS IN THE BUS	
Function	Start Address	Start Address	Start Address	Function	Start Address
1	2000	2000	2000	1	1999
3	10	40010	400010	3	9
2	2500	12500	102500	2	2499
4	1533	31533	301533	4	1532
3	15200	Cannot be seen	115200	3	15199

Table 23. 2 – Example of Modbus address on the old protocol (5 digits) or the current protocol (6 digits) and how the protocol stays internally (Modbus online)

The table above shows examples of Modbus addressing using both specifications: Modcon (with 5 digits) and the current one (with 6 digits).

The user input columns show an example of a given Modbus function and register.

The Modbus column on the bus shows a would-be Modbus protocol. Usually, the user does not see it, because it is inside the protocol for communication between devices. In this case, the initial bus

address is always a relative address, i.e., they generate the same command on the bus. In this case, the initial bus address is always a relative address discounted from the function base and it is unique for both representations.

Table 23.2 shows that both protocol views do not have any difference for communication, i.e., they generate the same bus command. The user then chooses which way he wants to work with, the old or the current one. The only difference will be when the device will have a very large address range (over 10000 registers) and so only the 6-digit format will be feasible.

NOTE
The DF89 supports the Modbus TCP and the Modbus RTU serial protocols. For both protocols the standard is the same under the old or current specs, and they are totally supported by the controller. The DF89 default is the 5-digit visualization, which is the most used. There are other non-standard Modbus protocol extensions, like Enron and Daniel, which are not supported by the DF89.

Types of data supported

On the Modbus, the points are mapped in registers. These registers differ, depending on the type of variable. For discrete types (functions 1, 2, 5, or 15), each register occupies a 2-byte word. Besides this information it is necessary to know which type of data corresponds to these registers. The information on the data types supported by the DF89 Modbus are the following:

Modbus Function	Data types Supported	Size in Bytes	Nr of Modbus Registers Necessary
1, 2, 5 or 15	BIT	1/8	1
3, 4, 6 or 16	UNSIGNED 8	1	1
3, 4, 6 or 16	UNSIGNED 16	2	1
3, 4 ,6 or 16	UNSIGNED 32	4	2
3, 4, 6 or 16	FLOAT_SINGLE	4	2
3, 4, 6 or 16	SIGNED 8	1	1
3, 4, 6 or 16	SIGNED 16	2	1
3, 4, 6 or 16	SIGNED 32	4	2

Table 23. 3 – Data types supported

Besides these data types, the analog data of 4 bytes size can be swapped or not. In this case, the type of swapped data has a little-endian data inversion relative to the big-endian non-swapped data type. This information is selected in the device inside the **Mapping Tool** and it is valid for the whole device.

For example, considering the number of 4 bytes 12345678 allocated on the Modbus 40001 and 40002 addresses:

	Register	Register
Datatype	40001	40002
Unsigned32	5678	1234
Swapped Unsigned32	1234	5678

Supervision and Control using DF89

The Modbus variables in the slave device can be mapped in DF89 by user in the following usage scenarios: supervision or control. As supervision, the variables are read cyclically via Modbus from the slave device and stored in the memory of DF89 and can be written on demand. As control, the variables are read cyclically (and do not allow writing) or written cyclically (and are never read).

Characteristic	Usage scenario: Supervision	Usage Scenario: Control
Modbus command configuration on SmarNetConf	Only Modbus commands for reading: - Read Coil (command 1) - Read Holding Register (command 3)	Modbus command to read or write: - Read Discrete Input (command 2) - Read Input Register (command 4) - Read Coil (command 1) - Read Holding Register (command 3) - Write Single Coil (command 5) - Write Single Register (command 6) - Write Multiple Coil (command 15) - Write Multiple Register (command 16)
Type of Modbus variable in the slave device and type of possible Modbus command.	Coil (address 0x.xxx or 0xx.xxx) and Holding Register (address 4x.xxx or 4xx.xxx) : Modbus command for reading	Discrete Input (address 1x.xxx or 1xx.xxx) and Input Register (address 3x.xxx or 3xx.xxx): Modbus command for reading Coil (address 0x.xxx or 0xx.xxx) and Holding Register (address 4x.xxx or 4xx.xxx): Modbus command for reading or written
Modbus variable on DF89 (cache)	Discrete Input (address 1x.xxx or 1xx.xxx) or Input Register (address 3x.xxx or 3xx.xxx) with float data type.	If Modbus command for reading: Discrete Input (address 1x.xxx or 1xx.xxx) or Input Register (address 3x.xxx or 3xx.xxx) with float data type. If Modbus command for written: Coil (address 0x.xxx or 0xx.xxx) or Holding Register (address 4x.xxx or 4xx.xxx)
Frequency of sending Modbus command for reading	Cyclic according to SmarNetConf configuration.	Cyclic according to SmarNetConf configuration.
Frequency of sending Modbus command for written	User demand. When writing occurs via Smar.DfiOleServer.	Cyclic according to SmarNetConf configuration.
Application	DF89 works as **concentrator for an OPC Server/Client** (it scans the slave devices and stores in the DF89 memory for host access). Despite the Modbus variable on DF89 is Discrete Input or Input Register, the written via Smar.DfiOleServer will be converted to written Modbus command to the slave device.	DF89 transfers cyclically a variable: - from a Modbus device to another one - from a Modbus device to a FF device - from a FF device to a Modbus device

Supervision

For example, in the HMI of example of figure 23.1 it is desired to map the point 40020 , which was a PID set point, and a contact 2001 that would be an on/off of a pump. The point will be created in **SmarNetConf** and **Mapping tool** as shown in steps 5 to 9 and would be as follows.

Modbus Function (SmarNetConf)	Start Address (SmarNetConf)	Point Tag (Mapping Tool)	Description
Read Coils (01)	2001	PLC_ID1_DI_1	On/Off Pump
Read Holding Registers (03)	40020	PLC_ID1_AI_1	SP of PID

These points were used in the ladder in a particular control strategy, and could also be mapped in supervisory via Smar.DfiOleServer. In supervisory, the value of points **PLC_ID1_DI_1** and **PLC_ID1_AI_1** can be changed by the user where the change will be mapped into a Modbus command of writing (function 5,6,15 or 16) and will be sent to the slave. The value of the next reading will already be the value really affected on the slave. If the point continues with the previous value means that the writing was not recognized by the slave.

On ladder it is not possible to alter the set point value, as the online ladder alteration does not admit writing on input parameters like this.

Peer-to-Peer of I/O point

A point mapped as peer-to-peer must be read on some slave device and written on other slave device.

For example, if the user wants to read the **PLC_ID1** set point value and write the **TRM_ID2** set point. In this case, the **PLC_ID1** set point must be mapped with any reading function (n.1, 2, 3 or 4), and the TRM_ID2 mapped with any writing function (n. 5, 6, 15 or 16). So, both ladder or function block logic can be used so that the point mapped as **PLC_ID1.PID1_SP** be written on **TRM_ID2.PID2_SP**.

Scan time between commands

The DF89 has the additional characteristic of choosing the scan time by command. By default, this parameter is 500 ms and must suit most applications. This value can be adjusted from 0 to 65500 ms (65.5 s).

The Modbus scan time allows the user setting different times for each command as multiples of 100 ms. For variable requiring a smaller periodicity, as analog variables, the Modbus time can be slower, for example, in relation to discrete points.

Scan time is also useful to prioritize the bypass. It refers only to the commands determined for the D89 to execute as a Modbus master and does not influence the Modbus bypass at all. So, if using a 1000 ms scan time and there is only one command, the DF89 will execute the scan command at each second. The rest of the time it can serve the bypass. That is, this makes bypass supervision much faster, as the bypass range is bigger in this case.

This is time is the time the user. However, as the scan depends on other commands to be executed, sometimes this time cannot be effected if the scan is much bigger than necessary. For example, imagine if the user has 5 commands to execute a device data (5 commands, including the optimization). And suppose that the user set the time of 100 ms for all commands. If the time for each command is 100 ms, then the time to do all the scan would be 500 ms. As the user configured 200 ms (desired time) the time had never been able to be done because the scan occurs at least every 500ms. If the user changes the time to 1000ms then will exist a gap between the scan of 500ms.

Optimization of commands

The DF89 has an additional command optimization feature. It consists on reducing the number of commands sent online and optimizes the Modbus communication. Use only the non-selected option when the Modbus slave really does not support the optimized commands.

Enabling and disabling a device in the configuration

Another interesting **Network Configurator** feature is the possibility of enabling and disabling a slave device on the configuration without affecting the device properties window where the user executes the device scan.

When the device is disabled, although the logic configuration and device mapping are not altered, the controller does not perform any other operation with this device, not sending any command to the slave.

The figure below shows a sample configuration with disabled devices. When the device is turned off it appears with a red (x) in the device drawing. In the figure below only the devices 10, 18 and 30 are enabled. This option is very useful when there are devices for maintenance.

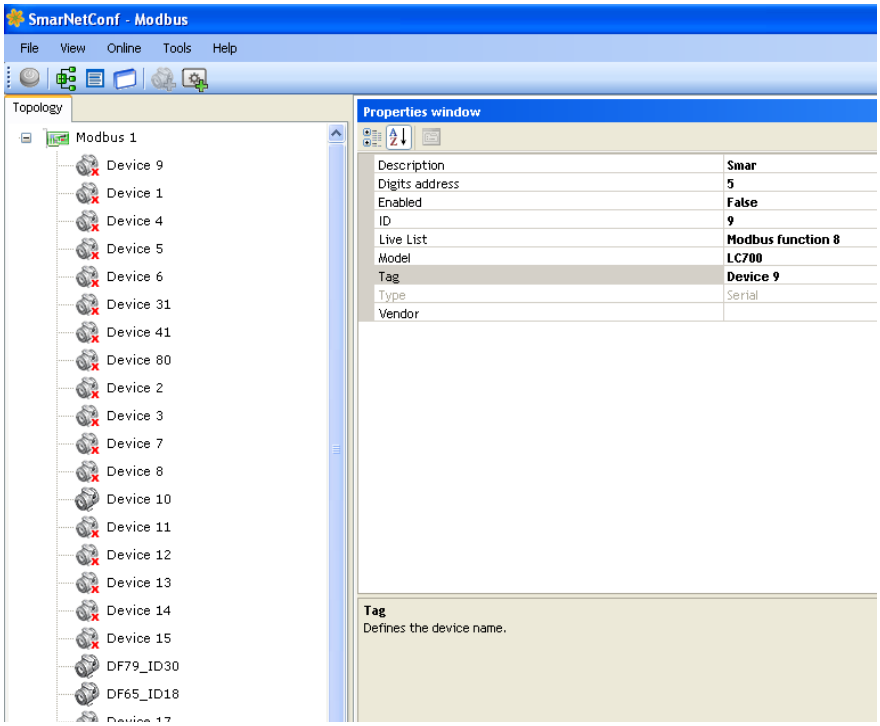


Figure 23. 34 – Example of configuration with enabled and disabled devices

This enabling change needs a download to the controller to recognize it. This download operation can be performed from the **Smar Network Configuration** or from **Syscon**.

To enable again the device, return to device's properties window and execute a new download.

Network Configurator online communication with the controller

Direct communication with the DF89 is possible through the **SmarNetConf.** It can facilitate some functions like slave channel parameter download, among others. This communication is carried out through the Ethernet network.

To enable Modbus communication through **SmarNetConf**, first enable communication with the OPC server.

SYSTEM302 Maintenance Procedure

This section presents a summary of download procedures recommended for cases of maintenance of a **SYSTEM302** configuration.

As the **SYSTEM302** has several download modes, there must be a general way that meets most cases. However, there are other procedures for the same alteration (consult the **Syscon** manual).

On the **Download Recommended** column the reference is the **Syscon** incremental download on the plant or on the controller. These operations are explained in detail in the **Syscon** manual.

MAINTENANCE EVENT	ALTERATION TOOL	RECOMMENDED DOWNLOAD
Make a new SYSTEM302 configuration with the Modbus controller and ladder logic. FFB block has no HSE links to other controllers.	Syscon, Network Configurator, Mapping Tool, LogicView for FFB	On Syscon make an incremental plant download with all selected options or a download on the controller (*).
Include a new device or a new command on the Modbus network	Network Configurator, Mapping Tool	On Syscon make an incremental plant download with all selected options.
Alter the device configuration on the Modbus network (device address, Modbus points addressing)	Network Configurator	Make an incremental plant download on the controller on Syscon(*).
Change specific parameters on the Modbus channel (*baud rate*, *timeout* or other parameter).	Network Configurator	Download the Modbus network on the Network Configurator (*)
Enable or disable Modbus device keeping the entire Modbus configuration	Network Configurator	Download the Modbus network on the Network Configurator (*)
Add parameters on the FFB block and make HSE links or only add FFB parameters to a FFB block that already has HSE link.	Syscon	On Syscon make an incremental plant download (*).
Include or remove FFB link for internal blocks inside the same controller.	Syscon	Make an incremental download on the controller without the enabled NetIO options (*).
Change of mapping parameters I/O points (scale, point tags, alteration of accessed or swapped bytes).	Mapping Tool	On Syscon make an incremental download on the controller with the NetIO Parameterization enabled option (*).
Change slave device configuration parameters (tag, model or number of visualization digits) or enable/disable the slave device.	Network Configurator	Download the Modbus network on the Network Configurator (*).
Alteration only of ladder logic.	LogicView for FFB	Download the logic on the LogicView for FFB.

Table 23.4 – Recommended download procedures

(*) These operations will stop the Modbus network channel

Smar Network Configurator Parameters

Serial Channel Parameters

Category	Parameter	Valid Range	Default	Unit	Description
Advanced					
	RTS CTS Timeout	0-65535	0	ms	Specifies the maximum waiting time for the CTS become active after sending RTS on the serial ports.
	Time delay	0-65535	0	ms	Waiting time between Rx reception and the next Tx transmission.
Media					
	Baud rate	0:110, 1:300, 2:600, 3:1200, 4:2400, 5:4800, 6:9600, 7:19200, 8:38400, 9:57600, 10:115200	9600	E	Define the baud rate of serial ports.
	Parity	0:Even, 1:Odd, 2:None.	Even	E	Defines the serial ports parity
	Retry Count	0-5	1		Number of retransmissions in case the master does not receive a response from the slave.
	Retry period	0-65536	10000		Time spent on a new live list check for the devices that failed on the scan.
	Stop bit	0:1, 1:2	1	E	Defines the number of stop bits for the serial ports.
	Timeout	0-65536	1000	ms	Waiting time for a slave response after sending a command to the serial ports.
Misc					
	Port number				1
	Tag				Channel tag
	Type				Serial
Redundancy					
	CHECK SECOND COMM	0 – Disable test 1 – 65535 Interval between each test	0	ms	Parameter configured for the secondary redundant port if user wants the communication test between slave devices.
	SECONDARY BYPASS	True/False	False		Parameter configured for the secondary redundant port if wanting to use the path as bypass for a TCP master to access the serial slave below the DF89.

TCP Channel Parameters

Category	Parameter	Valid Range	Default	Unit	Description
Media					
	RETRY COUNT	0-5	1		Number of retransmissions if the master does not receive a response from the slave.
	RETRY PERIOD	0-65536	0	ms	Time of retransmission if the master does not get a response from the slave.
	TIMEOUT	0-65536	1000	ms	Waiting time for a slave response after sending a command for the TCP ports.
Misc					
	PORT NUMBER			(read only)	2
	TAG			(read only)	Channel Tag
	TYPE			(read only)	TCP
Redundancy					
	CHECK SECOND COMM	0 – Disable test 1 – 65535 Interval between each test	0	ms	Parameter configured for the secondary DF89. If the user wants to perform the periodic communication test with the slaves to check the communication.
	Secondary Bypass	0 – False 1 – True	False		

Serial Device Parameters

Category	Parameter	Valid Range	Default	Unit	Description
Advanced					
	Digits address	5 or 6	5		Indicates if the “Modbus Address” will show the number with 5 or 6 digits, indicating if it is the old Modbus Modicon standard or a new one.
	Live List	1 – Use Modbus function 8. 2 – Use the First command	1		This parameter indicates which command will be used by the master and check if the device is alive. By default the loop back command (function 8) is used, though the device may not support this command. In this case, the user may choose option 2 and the first configured command will be sent.
Main					
	Enabled	0 – False 1 – True	1		This Field defines if, and on what conditions, the command must be executed. If the parameter is configured as 0, the command is disabled and won´t be executed in the normal polling sequence. If the parameter is configured as 1, the command will be executed on each command list scan.
	Slave address	1-247			This parameter specifies the node address, on the network, of the Modbus slave that will be considered. Values 1 to 247 are allowed.
Misc					
	Description				
	Model				
	Tag				Device tag
	Type				Serial
	Vendor				

TCP Device Parameters

Category	Parameter	Valid Range	Default	Unit	Description
Advanced					
	Digits address	5 or 6	5		Indicates if the “Modbus Address” will show the number with 5 or 6 digits, indicating if it is the old Modbus Modicon standard or a new one.
	Live List	1 – Use Modbus function 8. 2 – Use the First command	1		This parameter indicates which command will be used by the master to check if the equipment is alive (livelist). By default the loop back command (function 8) is used, though the equipment may not support this command. In this case, the user may choose option 2 and the first configured command will be sent.
Main					
	Enabled	0 – False 1 – True	1		This field defines if the command must be executed and under which conditions. If the parameter is configured as 0, the command is disabled and will not be executed on the normal polling sequence. If the parameter is configured as 1, the command is executed at each command list scan.
	Slave address	1-247			This parameter specifies the node address, on the network, of the slave device that will be considered. Values 1 to 247are allowed.
	IP		Spaces		Device main IP address
	IP2		Spaces		Redundant device IP address. See redundancy cases.
Misc					
	Description				
	Model				
	Tag				Device tag
	Type				TCP
	Vendor				

Parameters of device commands (serial or TCP)

Parameter	Valid Range	Default	Unit	Description
TAG				Device Tag
FUNCTION	The options are in according to Modbus supported functions table	1		This parameter specifies the Modbus function that will be executed by the command. These function codes are defined by the Modbus protocol. The next table defines the purpose of each action supported by the module.
OFFSET	0 to 65535	0		This parameter specifies the initial Modbus register or the digital point address to be considered by Modbus slave equipment command. Refer to each slave device documentation on the network to attribute their registers and digital point address.
REGISTERS	0 to 65535	0		This parameter specifies the number of registers and digital points to be associated to the command. Functions 5 and 6 ignore this field and their only apply to a single data point. For functions 1, 2 and 15, configure the number of digital registers to be associated to the command. For functions 3, 4 and 16 configure the number of analog registers to be associated to the command. Note: the register that may be associated to a point depends on the data type. See more about association of register and point in the item data type supported described in this section.
SCAN	0 to 65500 (multiple of 100)	500	ms	This parameter specifies the minimum interval to execute continuous commands periodically. This parameter must be multiple of 100. So, if the scan time is 500 the command will be executed at each 500 ms minimum.
OPTIMIZATION	0 – False 1 – True	1		When the parameter is true (checked on), indicates that it will be used to optimize the Modbus command where the algorithm tries to group multiple internal points of the same type and the same device in the same command.
START ADDR				This Field is a composition of function and Relative Address, which will be the Modbus address in the user language. It will depend also of the Nr_digits_addr parameter. See the Modbus Address mounting.

Modbus Functions Supported

The table below lists all Modbus functions supported by DF89 and their description. This function code follows the current Modbus specification Modbus Organization – Application Protocol Specification.

Modbus Function	MODBUS_FUNCTION Parameter	Class	Description
1	Read Coils (0x)	**RW**	Reading of Input/Output Discrete Points.
2	Read Discrete Inputs (1x)	**RO**	Reading of Input Discrete Points
3	Read Holding registers (4x)	**RW**	Reading of Input/Output Analog Points
4	Read Input registers (3x)	**RO**	Reading of Input Analog Points
5	Write Single Coil (0x)	**W**	Writing of Discrete Point (only 1 register)
6	Write Single Register (4x)	**W**	Writing of Analog Point (only 1 register)
15	Write Multiple Coils (0x)	**W**	Writing of Discrete Points (1 or more registers)
16	Write Multiple Registers (4x)	**W**	Writing of Analog Points (1 or more registers)

RW - Read and Write, RO - Read Only, W - Write Only

Besides these functions is also supported the function of checking the device function (8 - check). This function is used when starting the device to know if is alive or not (LiveList). In the LiveList parameter of the device the user may choose to use this function or the first function defined in the command table.

Specific blocks of DF89 controller

Modbus Communication Transducer

This block provides the following functionalities:

- Slave device live list;
- Slave device diagnostics;
- Parameter online configuration of slave configuration.

See in the table below the parameters description.

Idx	Parameter	Data type	Valid Range	Default	Memory	Mode	Unit	Description
1	ST_REV	Uns16			S	RO		
2	TAG_DESC	Octet			S	RW		
3	STRATEGY	Uns16			S	RW		
4	ALERT_KEY	UNS8			S	RW		
5	MODE_BLK	DS_69			S	RW		
6	BLOCK_ERR	Bitstr			D	RO		
7	SERIAL_CHANNEL	Uns8	0 : Slave 1 : Master	0	S	RO		Shows if the serial port is being used as Modbus master or slave.
8	BAUD_RATE	uns8	3:1200, 4:2400, 5:4800, 6:9600, 7:19200, 8:38400, 9:57600, 10:115200	9600	S	RO		Shows the current baud rate used on master or slave on the serial port.
9	STOP_BITS	uns8	0:1; 1:2	1	S	RO		Shows the current stop bit used on master or slave serial port.
10	PARITY	uns8	0:Even 1:Odd 2:None	Even	S	RO		Shows the current parity used on master or slave serial port.
11	SERIAL_TIMEOUT	Uns16	Positive	1000	S	RO	ms	Waiting time for the slave response using the serial port.
12	SERIAL_NR_RETRIES	Uns8	Positive	2	S	RO		Number of attempts of re-sending the failing serial port command.
13	SERIAL_RETRY_PERIOD	Uns16	Positive	5000	S	RO	ms	Time spent to re-send the command to the slave that does not respond.
14	RTS_CTS_TIMEOUT	uns16	Positive	0	S	RO	ms	Specifies the maximum waiting time for the CTS to be activated after the RTS is configured on the serial ports.
15	TIME_DELAY	uns16	Positive		S	RO	ms	Waiting time between Rx reception and the next Tx transmission.
16	SERIAL_CHK_COM_SEC	uns16	Positive		S	RO	sec	Indicates to redundancy if the information that the check will be made on the secondary path was configured.
17	BYPASS_SECONDARY	uns8	0=False; 1=True		S	RO		Indicates to redundancy if the user can use or not the secondary path as bypass
18	SERIAL_ENABLE_DEVS	Uns8			D	RO		List of devices enabled on the serial network. The number represents the slave device_address.
19	SERIAL_LIVE_LIST	Uns8			D	RO		List of devices connected to the serial network. The number represents the slave device_address.

20	SERIAL_ERR_CNT	Uns32		0	D	RO		Serial errors number counter. Use the RESET_COUNTERS to restart the counter.
21	SERIAL_SCAN_TIME	Uns32		0	D	RO		Time spent by the serial port to scan the Modbus variables.
22	TCP_TIMEOUT	uns16	Positive		S	RO		Waiting time for a slave response after sending a command on the TCP port.
23	TCP_NR_RETRIES	uns8	Positive		S	RO		Number of retransmissions if no the slave response is received.
24	TCP_RETRY_PERIOD	uns16	Positive		S	RO		Time to re-send the command to slave that is not responding.
25	TCP_CHK_COM_SEC	uns16	Positive		S	RO	s	Indicates to redundancy if the check on the secondary path will be configured
26	TCP_ENABLE_DEVS	Uns8			D	RO		List of device enabled on the TCP network. The number represents the slave device_address
27	TCP_LIVE_LIST	Uns8			D	RO		List of device connected to the TCP network.
28	TCP_ERR_CNT	Uns32		0	D	RO		TCP error number counter. Use RESET_COUNTERS to restart this counter.
29	TCP_SCAN_TIME	Uns32		0	D	RO		Time spent by the TCP port to scan the Modbus variables.
30	RESET_COUNTERS	Uns8			D	RW		Restart the TCP and Serial error counters.
31	NUM_LINKS	Uns8		1	S	RO		Defines the number of buses supported.
32	LINK_SEL	Uns8	0: First ; 1: Next ; 2: Previous ; 3: Last	First	D	RW		Selects which bus will show its information. Internal LiveList use.
33	LINK_ID	uns16		0	D	RW		Identifies the currently selected bus. Internal LiveList use.
34	LINK_ID_REV	Uns32		0	S	RO		Current bus LiveList revision. Internal use.
35	NUM_DEV	Uns16		0	D	RO		Number of devices on current bus for use on the LiveList.
36	SLAVE_SELECTOR	Uns8	0: First ; 1: Next ; 2: Previous ; 3: Last	First	D	RW		Slave address selector to read LiveList information. Internal use.
37	SLAVE_ADDR	uns8	1 to 247	0	D	RW		Slave parameter address for LiveList. Internal use.
38	UPDATE_EVT	DS-73			D			
39	BLOCK_ALM	DS-72			D			

Modbus Slave Configuration

See in the table below the parameters description.

Idx	Parameter	Data type	Valid Range	Default	Memory	Mode	Unit	Description
1	ST_REV	UNS16		0	S	RO		
2	TAG_DESC	OCT(32)		Spaces	S	RW		
3	STRATEGY	UNS16		0	S	RW		
4	ALERT_KEY	UNS8	1 to 255	0	S	RW		
5	MODE_BLK	DS_69	OOS , AUTO	OOS	S	RW		
6	BLOCK_ERR	Bitstr(2)			D	RO		
7	DEVICE_ADDRESS	uns8	1 to 247	1	S	RW		Defines the DFI302 Modbus address when working as Modbus slave.
8	BAUD_RATE	uns8	0:110, 1:300, 2:600, 3:1200, 4:2400, 5:4800, 6:9600, 7:19200, 8:38400, 9:57600, 10:115200	9600	S	RW		Defines the DFI302 serial port baud rate when working as Modbus slave. Defines the DFI302 Modbus address when working as Modbus slave.
9	STOP_BITS	uns8	0:1, 1:2	1	S	RW		Defines the DFI302 serial port stop bit when working as Modbus slave.
10	PARITY	uns8	0:Even, 1:Odd, 2:None	Even	S	RW		Defines the DFI302 serial port parity when working as Modbus slave.
11	RTS_CTS_TIMEOUT	uns16		0	S	RW	ms	When the value is other than zero, it indicates that the RTX_CTS function is enabled and the value is the connection timeout. Used when the DFI302 works as Modbus slave.
12	ENABLE_CHK_COM_SEC	Uns8		0-False ; 1-True	S	RW		When the DFI302 works as Modbus slave, this flag enables the redundancy, checks the communication on the secondary.
13	UPDATE_EVT	DS-73			D			
14	BLOCK_ALM	DS-72			D			

Redundancy and Modbus

The redundancy in Modbus communication may be mapped to many possible scenarios. Some of them are supported by the controllers. The restrictions which should be considered are described below:

1. The Modbus TCP in the DF89 will be established in both Ethernet ports (ETH1 and ETH2). It is recommended to use both ports only in the scenarios where the DF89 is slave. When running as Modbus Master, the DF89 should not be configured to use ETH2 to avoid duplication in the bandwidth and it may damage the communication performance.

2. The both Ethernet ports (ETH1 and ETH2) are available to answer the Modbus requests when the DF89 is slave.

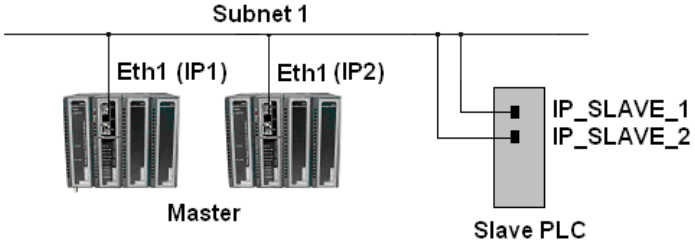
3. Switch over conditions are related to bad conditions in the Primary controller (see description of these bad conditions in another section of this manual "Adding Redundancy to DFI302 HSE Controllers"). As slave Modbus, the controllers will not generate a switch over condition because of communication failures. It is always the master who should switch over in such conditions. When using TCP and all IPs are in the same subnet, the master should to decide when switch the request to other slave Ethernet connection.

4. As Modbus Master, DF89 (either TCP or Serial RTU) only switch over if the Primary does not have any answer from all slave modules.

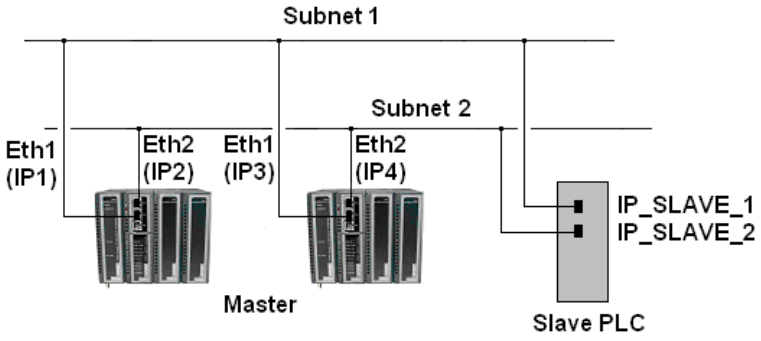
Redundant DF89 as master and PLC, with two Ethernet ports, as slave, using Modbus TCP

There are two possible scenarios, in the first only one subnet is used and all IPs of equipment are on the same subnet.

In the second scenario, two subnets are used, and each device has an Ethernet port connected to one of them, see the following figure. The second scenario is the most recommended if the availability of the Modbus communication is an important factor, because in this case if there is some failure in one switch the another network/subnet will cover this failure.



Scenario 1 - One subnet



Scenario 2 - Two subnets

Figure 23. 35 – Example of configuration with enabled and disabled devices
Network topologies for DF89 redundant master and slave PLC with two Ethernet ports

The redundant PLC can either use two Ethernet cards or one card with two Ethernet ports.

Once the Primary DF89 executes the requests, it is assumed that any of the slave connections may receive and process the request. If one connection is not running properly, the primary DF89 will use another available connection (connection switching).

If the Primary DF89 did not receive response to any of the connections and the Secondary DF89 has response to at least one of the connections, the DF89 pair will switch over (scenario Bad Condition/ controller switching).

Redundant DF89 as master and redundant PLC as slave, using Modbus RTU

In this scenario, the DF89 is redundant, using RS-485 serial port, and it is connected via multidrop to redundant PLC (both ports). Once the active DF89 executes the requests (see R1 in the following figure), it is assumed that only one slave will process the request. In case of any “bad condition” the DF89 will switch over (see R2 in the following figure).

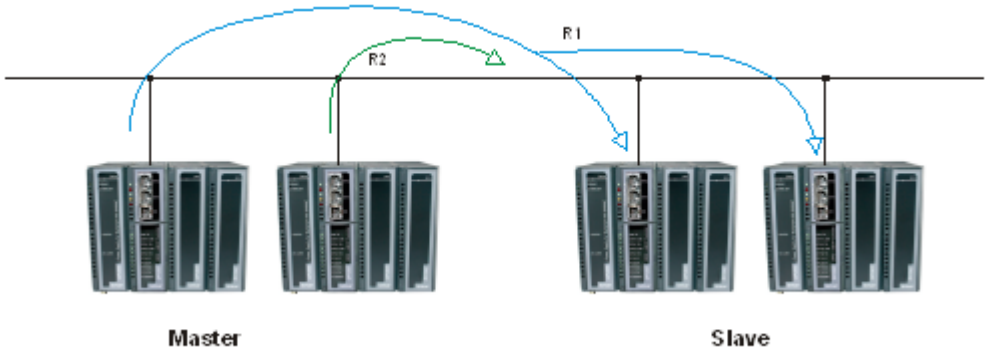


Figure 23. 36 – DF89 redundant master and PLC redundant slave, using Modbus RTU

Redundant DF89 as slave and redundant PLC as Master, using Modbus TCP

In this scenario, the Primary and the Secondary DF89 answer the reads requested by the Master PLC. The writes will be executed only by the Primary DF89. If for any reason the Secondary DF89 receives writing, so this request will be forwarded via redundancy path from Secondary DF89 to Primary DF89.

Redundant DF89 as slave and redundant PLC as Master, using Modbus RTU

In this scenario, only the Primary DF89 will answer the readings and writings requested by the Master PLC.